SA850/851
Double Sided
Diskette Storage Drive

OEM Manual

Shugart Associates

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FIGURE 1. SA850/851 DISKETTE STORAGE DRIVE

1.0 INTRODUCTION

1.1 General Description

The SA850/851 diskette storage drives are enhanced double-headed versions of the standard Shugart SA800/801 drives. SA850/851 drives provide up to four times the on-line storage capacity, faster access time, and lower heat dissipation along with improved reliability and maintainability.

SA850/851 drives read and write in single or double density on standard diskettes and on both sides of two-sided diskettes. The new drives are exactly the same size as Shugart SA800/801 drives and are plug compatible. The SA850/851 drives are also media compatible with IBM 3740 and S/32 single-sided drives as well as IBM 4964 and 3600 series two-sided units.

The new proprietary Fasflex^{TM} actuator utilizes a flexible metal band for sure low friction head movement and a fast 3 ms track-to-track access time. The read/write heads are also proprietary and are mounted on a newly developed head carriage assembly which allows the heads to be loaded simultaneously on both sides of the diskette. This flexured mounting arrangement provides excellent compliance and minimum wear.

Other valuable features include: new programmable door lock and write protect plus dual index sensor to differentiate between single and two-sided diskettes.

With the elimination of the head load pad and the simplification of actuator and head carriage assemblies, maintenance is greatly reduced and serviceability enhanced.

The new SA850/851 will prove highly cost-effective in applications such as: intelligent terminals, minicomputer/microcomputer systems, program storage, point-of-sale systems, small business systems as well as word processing systems and intelligent calculators.

Key Features

- Storage capapcity of up to four times that of SA800 and other standard floppy drives.

- Single or double density (standard).

- Same physical size as standard SA800/801 product family.

- SA800/801 I/O compatibility.

- Reads and writes data on any standard diskette (single-sided) as well as the IBM Diskette 2 or equivalent.

- Improved access time over standard drives—3 ms track-to-track.

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- New proprietary Fasflex™ actuator.
- New improved head carriage assembly loads heads on both sides of diskette simultaneously, eliminating head load pad.
- Same proprietary R/W head technology as standard Shugart drives.
- Write protect and programmable door lock are standard for improved data security.

The SA851 is designed for ease of use in hard sector applications. Two Model SA850R/851R units mount side-by-side in standard 19" RETMA rack.

1.2 Specification Summary

1.2.1 Performance Specifications

Capacity	Single Density	Double Density
Unformatted		
Per Disk	800 kilobytes	1600 kilobytes
Per Surface	400 kilobytes	800 kilobytes
Per Track	5.2 kilobytes	10.4 kilobytes
IBM Format (128 byte sectors)		
Per Disk	500 kilobytes	1000 kilobytes
Per Surface	250 kilobytes	500 kilobytes
Per Track	3.3 kilobits	6.66 kilobytes
Transfer Rate	250 kilobits/sec.	500 kilobits/sec
Latency (Avg.)	83 ms	83 ms
Access Time		
Track to Track	3 ms	3 ms
Average (including settling)	91 ms	91 ms
Settling Time	15 ms	15 ms
Head Load Time	35 ms	35 ms

1.2.2 Functional Specifications

	Single Density	Double Density
Rotational Speed	360 rpm	360 rpm
Recording Density (inside track)	3408 bpi	6816 bpi
Flux Density	6816 fci	6861 fci
Track Density	48 tpi	48 tpi
Cylinders	77	77
Tracks	154	154
Heads	2	2
Physical Sectors		
SA850/R	0	0
SA851/R	32/16/8	32/16/8
Index	1	1
Encoding Method	FM	MFM/M^{2}FM
Media Requirements		
SA850	SA150/IBM Diskette 2,2D	SA150/IBM Diskette 2,2D
SA851	SA151	SA151
Alignment Diskette	SA120	SA120

1.2.3 Physical Specifications

Environment Limits
Ambient Temperature	=	40°F to 115°F (4.4°C to 46.1°C)
Relative Humidity	=	20% to 80%
Maximum Wet Bulb	=	78°F (25°C)

AC Power Requirements
50/60 Hz ± 0.5 Hz
100/115 VAC Installations	=	85 to 127V @ .4A typical
200/230 VAC Installations	=	170 to 253V @ .2A typical

DC Voltage Requirements
+24 VDC ± 10% 0.6A typical
+ 5 VDC ± 5% 0.9A typical
$-$ 7 to –16 VDC, 0.07A typical (option –5 VDC ± 5%, 0.05A typical)

Mechanical Dimensions (exclusive of front panel)

		SA850R/851R	SA850/851
Height	=	4.62 in. (117 mm)	4.62 in. (117 mm)
Width	=	8.55 in. (217 mm)	9.50 in. (241 mm)
Depth	=	14.25 in. (363 mm)	14.25 in. (362 mm)
Weight	=	13.0 lbs. (5.91 kg)	13.0 lbs. (5.91 kg)

Heat Dissipation 195 BTU/hr. typical (57 watts)

1.2.4 Reliability Specifications

MTBF:	5000 POH under heavy usage. 8000 POH under typical usage.
MTTR:	·30 minutes.
Component Life:	15,000 POH.

Error Rates:
Soft Read Errors:	1 per 10^9 bits read.
Hard Read Errors:	1 per 10^{12} bits read.
Seek Errors:	1 per 10^6 seeks.

Media Life:
Passes per Track	3.5×10^6
Insertions:	30,000+

2.0 FUNCTIONAL CHARACTERISTICS

2.1 General Operation

SA850/851 Diskette Storage Drives consist of read/write and control electronics, drive mechanism, two read/write heads and a track positioning mechanism. These components perform the following functions:

> Interpret and generate control signals.
> Move read/write heads to the selected track.
> Read and write data.

The Fasflex™ Head Positioning Actuator positions the read/write heads to the desired track on the diskette. The Head Load Solenoid loads the read/write heads against the diskette and data may then be recorded on or read from the diskette.

2.2 Read/Write and Control Electronics

The electronics are packaged on one PCB. The PCB contains:

1. Index Detector Circuits (Sector/Index for 851)

2. Head Position Actuator Driver

3. Head Load Solenoid Driver

4. Read/Write Amplifier Transition Detector

5. Data/Clock Separation Circuits (SA851 only)

6. Write Protect

7. Drive Ready Detector Circuit

8. Drive Select Circuits

9. Side Select Circuit

10. In Use and Door Lock Circuits
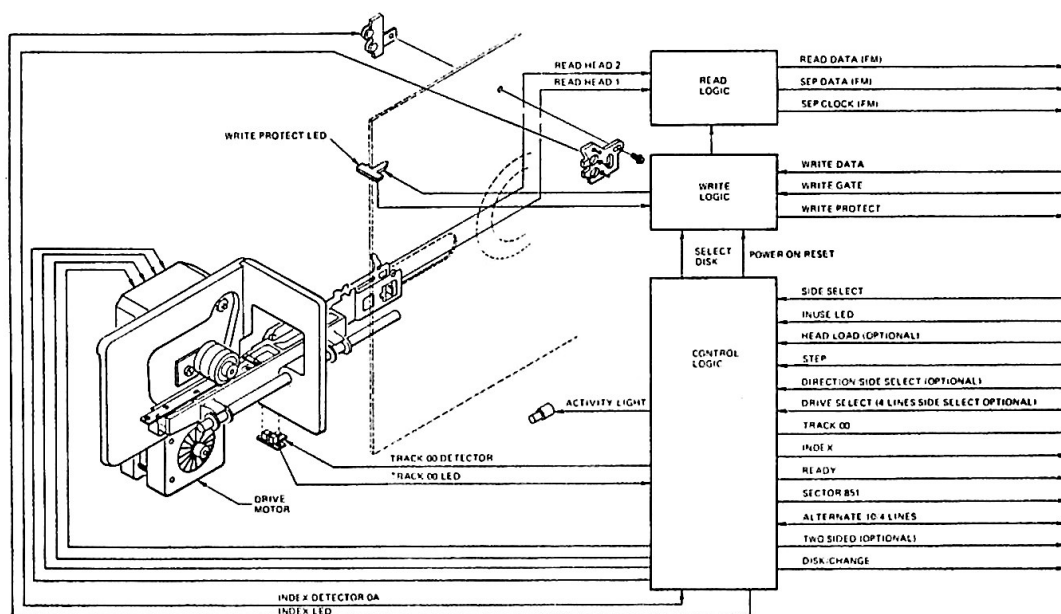
FIGURE 2. SA850/851 FUNCTIONAL DIAGRAM

2.3 Drive Mechanism

The Diskette drive motor rotates the spindle at 360 rpm through a belt-drive system. 50 or 60 Hz power is accommodated by changing the drive pulley and belt. A registration hub, centered on the face of the spindle, positions the Diskette. A clamp that moves in conjunction with the cartridge guide fixes the Diskette to the registration hub.

2.4 Positioning Mechanism

The read/write heads are accurately positioned by Fasflex™ metal band/stepping motor actuator system. A precision stepping motor is used to precisely position the head/carriage assembly through the use of a unique metal band/capstan concept. Each 3.6° rotation of the stepping motor moves the read/write head one track in discrete increments.

2.5 Read/Write Heads

The proprietary heads are a single element ceramic read/write head with straddle erase elements to provide erased areas between data tracks. Thus normal interchange tolerances between media and drives will not degrade the signal to noise ratio and insures diskette interchangeability.

The read/write heads are mounted on a carriage which is positioned by the Fastflex™ actuator. The diskette is held in a plane perpendicular to the read/write heads by a platen located on the base casting. This precise registration assures perfect compliance with the read/write heads. Both heads are loaded against the diskette by the head load solenoid. The read/write heads are in direct contact with the diskette. The head surface has been designed to obtain maximum signal transfer to and from the magnetic surface of the diskette with minimum head/diskette wear.

3.0 FUNCTIONAL OPERATIONS

3.1 Power Sequencing

Applying AC and DC power to the SA850/851 can be done in any sequence, however, once AC power has been applied, a 2 second delay must be introduced before any Read or Write operation is attempted. This delay is for stabilization of the Diskette rotational speed. Also, after application of DC power, a 90 millisecond delay must be introduced before a Read, Write, or Seek operation or before the control output signals are valid. After powering on, initial position of the R/W heads with respect to data tracks is indeterminable. In order to assure proper positioning of the R/W heads prior to any read/write operation after powering on, a Step Out operation should be performed until the Track 00 indicator becomes active.

3.2 Drive Selection

Drive selection occurs when a drive's Drive Select line is activated. Only the drive with this line active will respond to input lines or gate output lines. Under normal operation, the Drive Select line will load the R/W head, apply power to the stepper motor, enable the input lines, activate the output lines, light the Activity LED on the front of the drive and lock the door. Optional modes of drive selection are discussed in Section 7.0.

3.3 Track Accessing

Seeking the R/W head from one track to another is accomplished by:

a. Activating Drive Select line.

b. Selecting desired direction utilizing Direction Select line.

c. Write Gate being inactive.

d. Pulsing the Step line.

Multiple track accessing is accomplished by repeated pulsing of the Step line until the desired track has been reached. Each pulse on the Step line will cause the R/W heads to move one track either in or out depending on the Direction Select line. Head movement is initiated on the trailing edge of the Step Pulse.

3.3.1 Step Out

With the Direction Select line at a plus logic level (2.5V to 5.25V) a pulse on the Step line will cause the R/W heads to move one track away from the center of the disk. The pulse(s) applied to the Step line and the Direction Select line must have the timing characteristics shown in Figure 3.
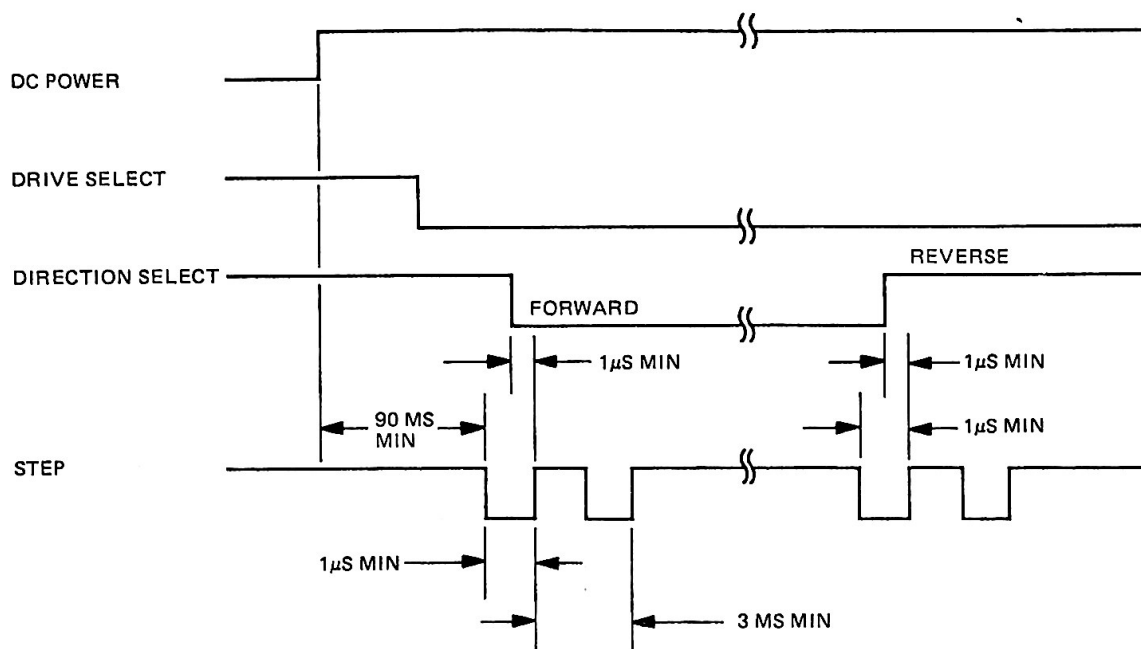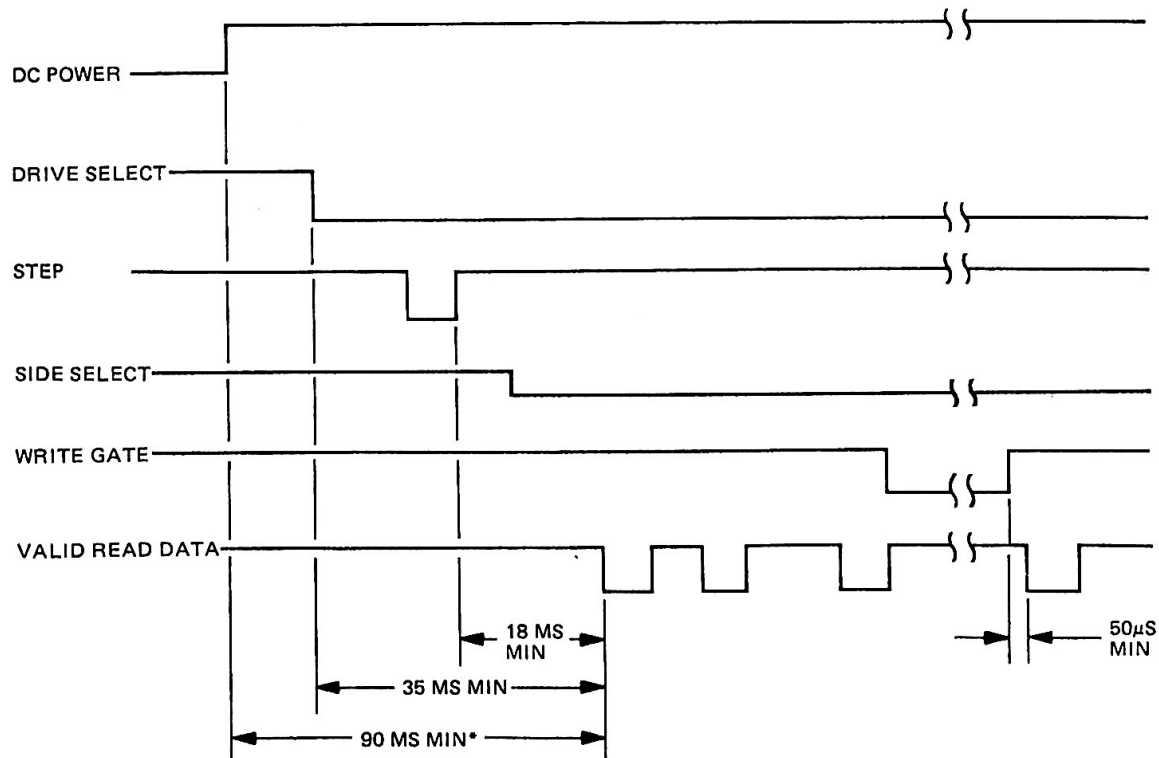
FIGURE 3. TRACK ACCESS TIMING

*2 SECONDS IF AC AND DC POWER ARE APPLIED AT SAME TIME

FIGURE 4. READ INITIATE TIMING

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3.3.2 Step In

With the Direction Select line at a minus logic level (0V to .4V), a pulse on the Step line will cause the R/W heads to move one track closer to the center of the disk. The pulse(s) applied to the Step line must have the timing characteristics shown in Figure 3.

3.4 Side Selection

In the standard SA850/851, head selection is controlled via the I/O signal line designated Side select. A plus logic level on the Side Select line selects the R/W head on the side 0 surface of the diskette. A minus logic level selects the side 1 R/W head. When switching from one side to the other, a 100 μs delay is required after Side Select changes state before a read or write operation can be initiated. Figure 4 shows the use of Side Select prior to a read operation.

Two jumper-selectable Side Select options are also available. Either of these can be implemented to make use of existing controller and cable harness design. These options are described fully in Section 7.

3.5 Read Operation

Reading data from the SA850/851 Diskette Storage drive is accomplished by:

a. Activating Drive Select line.

b. Selecting head (if necessary).

c. Write Gate being inactive.

The timing relationships required to initiate a read sequence are shown in Figure 4. These timing specifications are required in order to guarantee that the R/W head position has stabilized prior to reading.

The coding scheme of the recorded data can be FM, MFM or M^{2}FM. The first of these, FM, provides single-density recording. The superior efficiency of the other two codes permit their bit cell period to be ½ that of the FM code, thereby providing double-density recording. Differences among FM, MFM and M^{2}FM encoding are concerned with the use of clock bits in the write data stream.

FM encoding rules specify a clock bit at the start of every bit cell. See Figure 5. MFM and M^{2}FM encoding rules allow clock bits to be omitted from some bit cells, with the following prerequisites:

a. MFM — The clock bit is omitted from the current bit cell if either the preceding bit cell or the current bit cell contains a data bit. See Figure 5.

b. M^{2}FM — The clock bit is omitted from the current bit cell if the preceding bit cell contained any bit (clock or data) or if the current bit cell contains a data bit. See Figure 5.

In all three of these encoding schemes, clock bits are written at the start of their respective bit cells and data bits at the centers of their bit cells.

The timing of the read signals, Read Data, Separated Data and Separated Clock are shown in Figure 6 (FM encoding),

In the standard SA851, data separation of FM data is performed by drive electronics. Data bits are presented to the controller on the Sep Data line and clock bits are presented on the Sep Clock line. In systems using the SA850 or when MFM/M^{2}FM encoding is used, data separation is performed outside the drive. In such cases, the Read Data line carries both clock bits and data bits. Separation of MFM or M^{2}FM encoded read data should be controlled by a phase-locked loop oscillator (PLO) circuit.

For additional information regarding the use of MFM and M^{2}FM encoding with SA850/851 drives, refer to Shugart Associates' Double Density Design Guide.

3.6 Write Operation

Writing data to the SA850/851 is accomplished by:

a. Activating the Drive Select line.

b. Selecting head (if necessary).

c. Activating the Write Gate line.

d. Pulsing the Write Data line with the data to be written.

The timing relationships required to initiate a write data sequence are shown in Figure 7. These timing specifications are required in order to guarantee that the R/W head position has stabilized prior to writing.

Write data encoding can be FM, MFM or M^{2}FM. If either double-frequency encoding scheme is used (MFM or M^{2}FM) the write data should be precompensated to counter the effects bit shoft. The amount and direction of compensation required for any given bit in the data stream depends on the pattern it forms with nearby bits.

For more details regarding data encoding and formatting for SA850/851 drives, refer to the Shugart Associates' Double Density Design Guide.

3.7 Sequence of Events

The timing diagram shown in Figure 9 shows the necessary sequence of events with associated timing restrictions for proper operation.
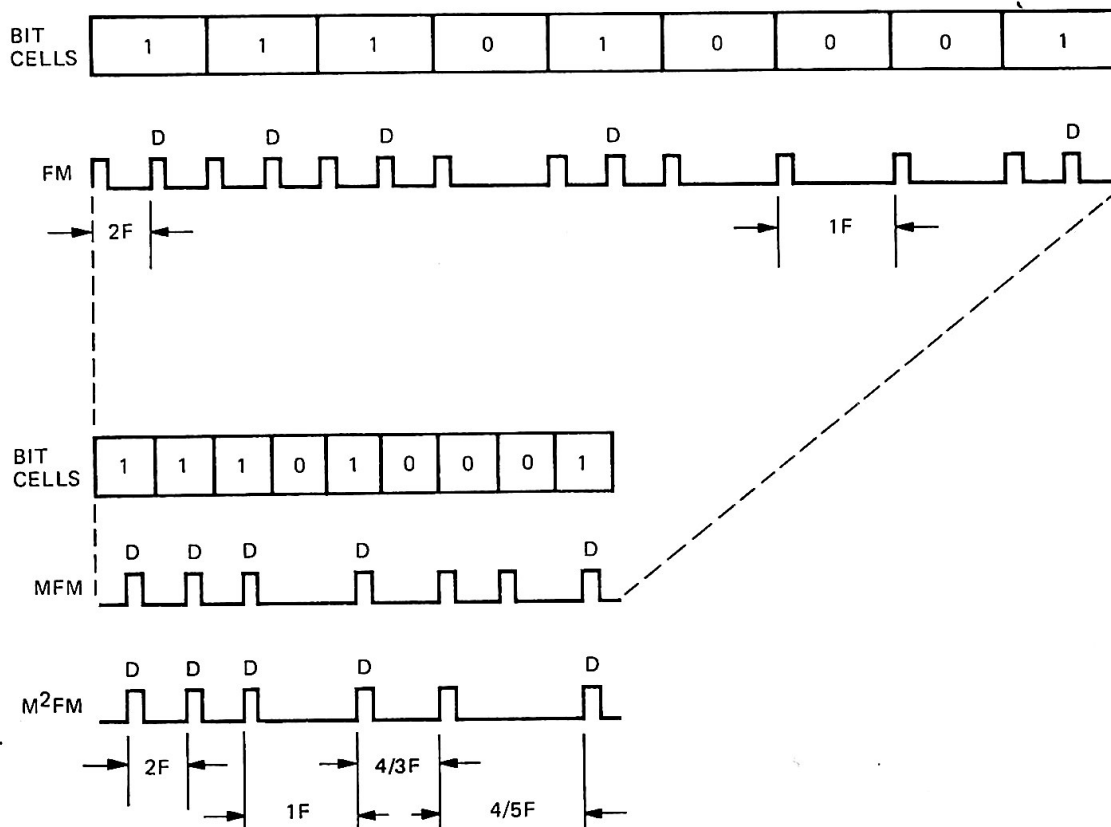
FIGURE 5. FM, MFM AND M²FM CODE COMPARISONS
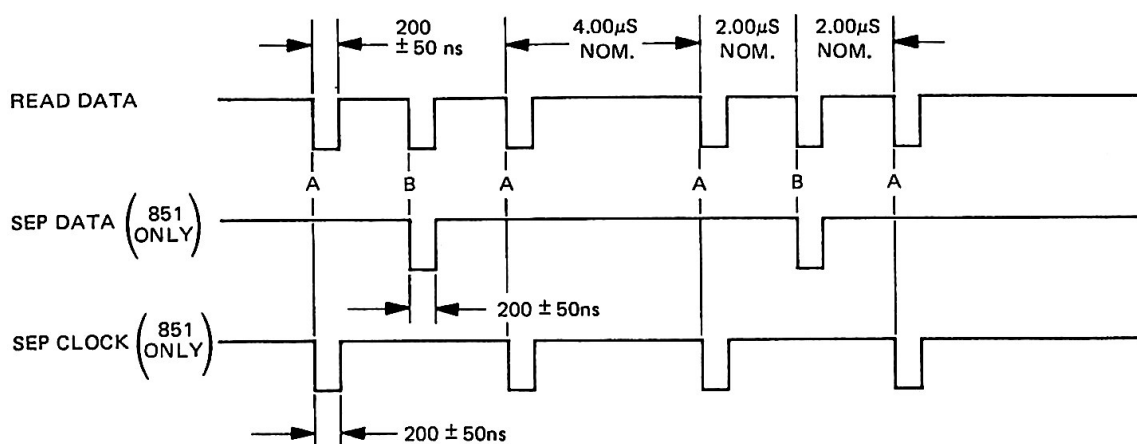
A = LEADING EDGE OF BIT MAYBE ± 400ns FROM ITS NOMINAL POSITION.
B = LEADING EDGE OF BIT MAYBE ± 200ns FROM ITS NOMINAL POSITION.

FIGURE 6. READ SIGNAL TIMING (FM ENCODING)
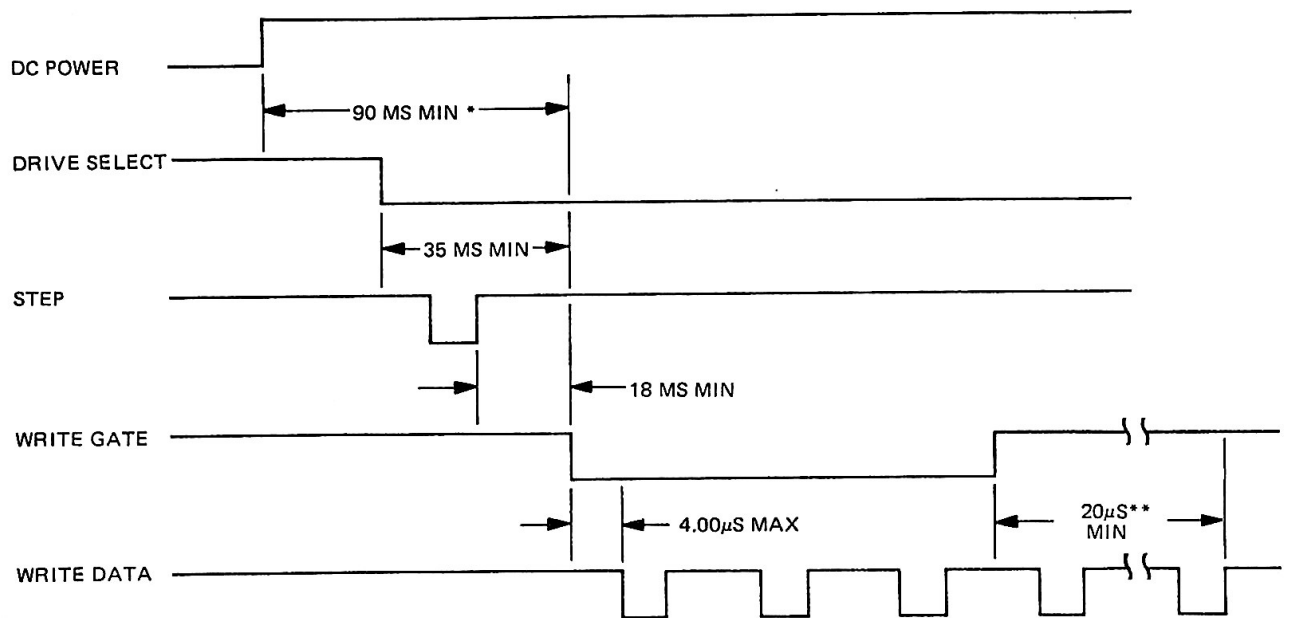
* 2 SECONDS IF AC AND DC POWER ARE APPLIED AT SAME TIME.
** HEAD DEGAUSS TIME.

FIGURE 7. WRITE INITIATE TIMING
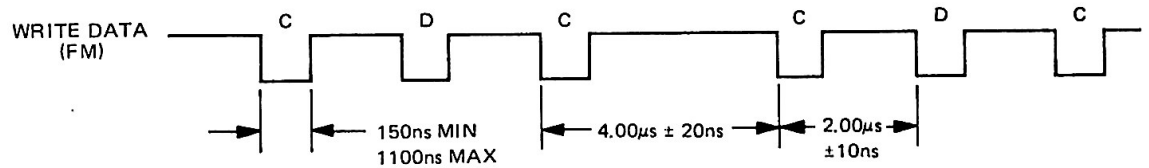
FIGURE 8. WRITE DATA TIMING (EM ENCODING)

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FIGURE 9. GENERAL CONTROL AND DATA TIMING REQUIREMENTS
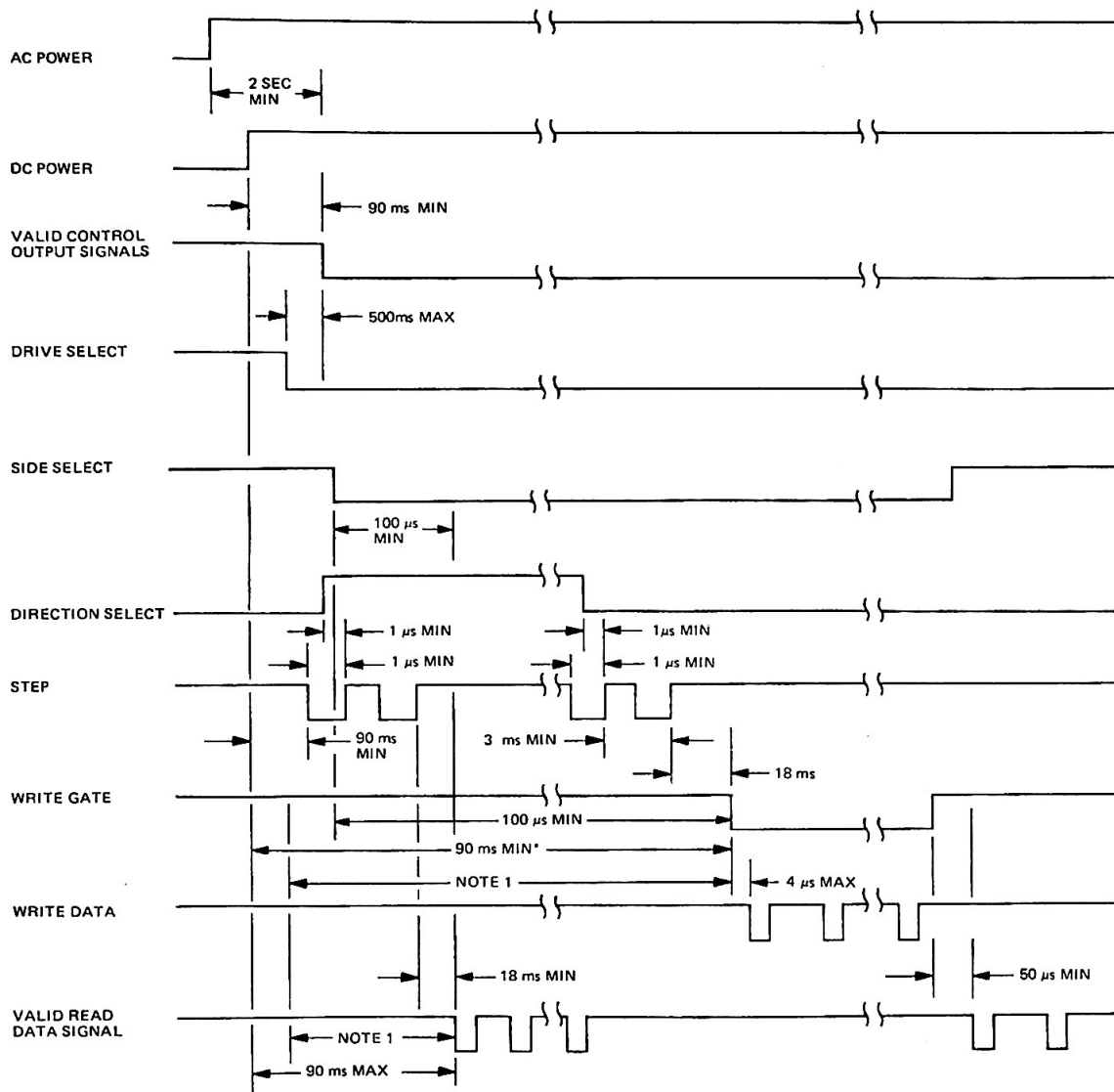
*2 SECONDS IF AC AND DC POWER ARE APPLIED AT SAME TIME

NOTE 1   35 ms minimum delay must be introduced after Drive Select to allow
for proper head load setting. If stepper power is to be applied independent
of Head Load, then a 15 ms minimum delay must be introduced to allow
for stepper setting. See section 7 on optional customer installable features.

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4.0 ELECTRICAL INTERFACE

The interface of the SA850/851 Diskette drive can be divided into two categories:

1. Signal

2. Power

The following sections provide the electrical definition for each line.

Reference Figure 10 for all interface connections.

4.1 Signal Interface

The signal interface consists of two categories.

1. Control

2. Data transfer

All lines in the signal interface are digital in nature and either provide signals to the drive (input), or provide signals to the host (output), via interface connector P1/J1.

4.1.1 Input Lines

There are eleven (11) signal input lines, nine (9) are standard and two (2) are user installable options (reference section 7).

The input signals are of two types, those intended to be multiplexed in a multiple drive system and those which will perform the multiplexing. The input signals to be multiplexed are:

1. Direction Select

2. Step

3. Write Data

4. Write Gate

5. Side Select

The input signals which are intended to do the multiplexing are:

1. Drive Select 1

2. Drive Select 2

3. Drive Select 3

4. Drive Select 4

The input lines have the following electrical specifications. Reference Figure 10 for the recommended circuit.

True = Logical zero = Vin ± 0.0V to + 0.4V
@Iin = 40 ma (max)

False = Logical one = Vin + 2.5V to + 5.25V
@Iin = 0 ma (open)

Input Impedance = 150 ohms

FLAT RIBBON OR
TWISTED PAIR
MAX 10 FEET

HOST SYSTEM

SA 850-851

TWO SIDED* — 10 — 9
DISK CHANGE* — 12 — 11
SIDE SELECT — 14 — 13
IN USE* — 16 — 15
HEAD LOAD* — 18 — 17
INDEX — 20 — 19
READY — 22 — 21
SECTOR(851 ONLY) — 24 — 23
DRIVE SELECT 1 (SIDE SELECT OPT) — 26 — 25
DRIVE SELECT 2 (SIDE SELECT OPT) — 28 — 27
DRIVE SELECT 3 (SIDE SELECT OPT) — 30 — 29
DRIVE SELECT 4 (SIDE SELECT OPT) — 32 — 31
DIRECTION SELECT (SIDE SELECT OPT) — 34 — 33
STEP — 36 — 35
WRITE DATA — 38 — 37
WRITE GATE — 40 — 39
TRACK 00 — 42 — 41
WRITE PROTECT — 44 — 43
READ DATA — 46 — 45
SEP DATA (851 ONLY) — 48 — 47
SEP CLOCK (851 ONLY) — 50 — 49

J5
+5 VDC — 5 — 6
-7 TO -16 VDC (-5 V OPT) — 4 — 3
+24 VDC — 1 — 2
+24 V RETURN

DC GND

J4
AC INPUT — 1
FRAME GROUND — 2
AC INPUT — 3
FRAME GND

AC GND

TWISTED PAIR

*These lines are alternate input/output lines and they are enabled by plugs. Reference section 7 for uses of these lines. Not shown are pins 2, 4, 6, and 8 which are alternate I/O pins.

FIGURE 10. INTERFACE CONNECTIONS

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4.1.1.1 Input Line Termination

The SA850/851 has been provided with a removable resistor pack for terminating the five input lines that are to be multiplexed.

In order for the drive to function properly, the last drive on the interface must have these five lines terminated. Termination of these lines can be accomplished by either of two methods.

1. As shipped from the factory, the resistor pack is installed in location 3H. These packs can be removed from all drives except the last one on the Interface.

2. External termination may be used provided the terminator is beyond the last drive. Each of the five lines should be terminated by using a 150 ohm, ¼ watt resistor, pulled up to + 5 VDC.

The same removable resistor pack is also provided for terminating the optional input lines.

4.1.1.2 DriveSelect 1 – 4

Drive Select when activated to a logical zero level, activates the multiplexed I/O lines and loads the R/W head. In this mode of operation only the drive with this line active will respond to the input lines and gate the output lines.

Four separate input lines, Drive Select 1, Drive Select 2, Drive Select 3, and Drive Select 4, are provided so that up to four drives may be multiplexed together in a system and have separate Drive Select lines. Traces 'DS1', 'DS2', 'DS3', and 'DS4' have been provided to select which Drive Select line will activate the interface signals for a unique drive. As shipped from the factory, a shorting plug is installed on 'DS1'. To select another Drive Select line, this plug should be moved to the appropriate 'DS' pin. For additional methods of selecting drives, see section 7.1.

4.1.1.3 Side Select

This interface line defines which side of a two-sided diskette is used for reading or writing. An open circuit, or logical one, selects the R/W head on the side 0 surface of the diskette. A short to ground, or logical zero, selects the R/W head on the diskette's side 1 surface. When switching from one head to the other, a 100 μs delay is required before any read or write operation can be initiated.

Two optional methods of side selection are available and can be implemented by the user through appropriate jumper connections. These options are described in Sections 7.11 and 7.12.

4.1.1.4 Direction Select

This interface line is a control signal which defines direction of motion the R/W heads will take when the Step line is pulsed. An open circuit or logical one defines the direction as "out" and if a pulse is applied to the Step line the R/W heads will move away from the center of the disk. Conversely, if this input is shorted to ground or a logical zero level, the direction of motion is defined as "in" and if a pulse is applied to the step line, the R/W heads will move towards the center of the disk.

A jumper-selectalbe option is available, which allows the Direction Select line to be time shared for both the Direction Select and Side Select functions. That is, during head positioning operations, the Direction Select line controls direction of head motion and during read or write operations, the Direction Select line determines which head is selected. Details regarding the implementation of this option are provided in Section 7.11.

4.1.1.5 Step

This interface line is a control signal which causes the R/W heads to move with the direction of motion as defined by the Direction Select line.

The access motion is initiated on each logical zero to logical one transition, or the trailing edge of the signal pulse. Any change in the Direction Select line must be made at least 1 μs before the trailing edge of the Step pulse. Refer to Figure 3 for these timings.

4.1.1.6 Write Gate

The active state of this signal (logical zero) enables Write Data to be written on the diskette. The inactive state (logical one) enables the read data logic (Separated Data, Separated Clock, and Read Data) and stepper logic. Refer to Figure 7 for timing information.

4.1.1.7 Write Data

This interface line provides the data to be written on the diskette. Each transition from a logical one level to a logical zero level will cause the current through the R/W head to be reversed, thereby writing a data bit. This line is enabled by Write Gate being active. Refer to Figure 8 for timing information.

4.1.1.8 Head Load (Alternate Input)

This customer installable option, when enabled by jumpering Trace "C" and activated to a logical zero level and the diskette access door is closed, will load the R/W heads against the diskette. Refer to section 7 for uses and method of installation.

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4.1.1.9 In Use (Alternate Input)

This customer installable option, when enabled by jumpering Trace "D" and activated to a logical zero level will turn on the Activity LED in the door push button and will lock the door. This signal is an "OR" function with Drive Select. Refer to section 7.8 for uses and method of installation.

4.1.2 Output Lines

There are five standard output lines from the SA850, and eight standard output lines from the SA851. Also, there are two optional output lines and eight alternate outputs available from either the SA850 or SA851. The output signals are driven with an open collector output stage capable of sinking a maximum of 40 ma at a logical zero level or true state with a maximum voltage of 0.4V measured at the driver. When the line driver is in a logical one or false state, the driver is off and the collector current is a maximum of 250 microampers.
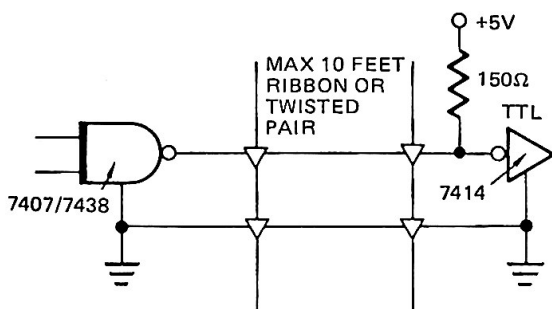
Refer to Figure 11 for the recommended circuit.

FIGURE 11. INTERFACE SIGNAL DRIVER/RECEIVER

4.1.2.1 Track 00

The active state of this signal, or a logical zero indicates when the drive's R/W heads are positioned at track zero (the outer most track) and the access circuitry is driving current through phase one of the stepper motor. This signal is at a logical one level, or false state, when the selected drive's R/W heads are not at track 00.

4.1.2.2 Index

This interface signal is provided by the drive once each revolution of the diskette (166.67 ms) to indicate the beginning of the track. Normally this signal is a logical one and makes the transition to the logical zero level for a period of 1.8 ms (0.4 ms

on SA851) once each revolution. The timing for this signal is shown in Figure 12.

To correctly detect Index at the control unit, Index should be false at Drive Select time; that is, the CU should see the transition from false to true after the drive has been selected.

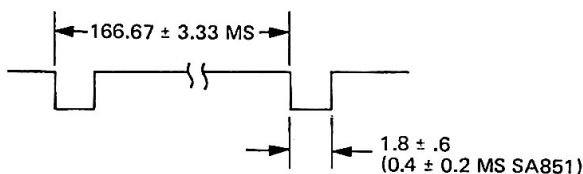For additional methods of detecting Index, refer to section 7.6.

FIGURE 12. INDEX TIMING

4.1.2.3 Sector (SA851 only)

This interface signal is provided by the drive 32 times each revolution. Normally, this signal is a logical one and makes the transition to a logical zero for a period of 0.4 ms each time a sector hole on the Diskette is detected. Figure 13 shows the timing of this signal and its relationship to the Index pulse.

For additional methods of detecting Sector refer to section 7.7.

Note: Index/Sector pulses should not be used for loading the Read/Write heads as this may cause unusual media wear in one spot on the diskette.

4.1.2.4 Ready

This interface signal indicates that two index holes have been sensed after properly inserting a diskette and closing the door, or that two index holes have been sensed following the application of +5V power to the drive.

If a single sided diskette is installed, READY will be active (logical zero) if SIDE 0 is selected, but false (logical 1) if SIDE 1 is selected. Conversely, if a two-sided diskette is installed, READY will be active when either side of the diskette is selected.

For additional methods of using the Ready line, refer to section 7.5.

4.1.2.5 Read Data

This interface line provides the "raw data" (clock and data together) as detected by the drive electronics. Normally, this signal is a logical one level and becomes a logical zero level for the active state. Reference Figure 6 for the timing and bit shift tolerance within normal media variations.
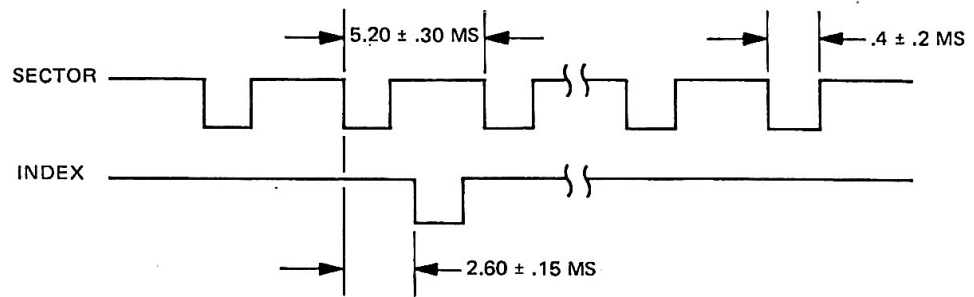
FIGURE 13. SECTOR TIMING

4.1.2.6 Sep Data (SA851 only)

This interface line furnishes the data bits as separated from the "raw data" by use of the internal data separator. Normally, this signal is a logical one level and becomes a logical zero level for the active state. Reference Figure 6 for the timing.

4.1.2.7 Sep Clock (SA851 only)

This interface line furnishes the clock bits as separated from the "raw data" by use of the internal data separator. Normally, this signal is a logical one level and becomes a logical zero level for the active state. Reference Figure 6 for the timing.

4.1.2.8 Write Protect

This interface signal is provided by the drive to give the user an indication when a Write Protected Diskette is installed. The signal is logical zero level when it is protected. Under normal operation, the drive will inhibit writing with a protected diskette installed in addition to notifying the interface.

For other methods of using Write Protect, refer to section 7.9.

To enable the data separator on the SA850, move the sector enable plug to 850 and the TS/FS plug to TS.

4.1.2.9 Disk Change (Alternate Output)

Reference section 7.10.

4.1.2.10 Two Sided (Alternate Output)

Reference section 7.14.

4.1.3 Alternate I/O Pins

These interface pins have been provided for use with customer installable options. Refer to section 7 for methods of use.

4.2 Power Interface

The SA850/851 Diskette Storage Drive requires both AC and DC power for operation. The AC power is used for the spindle drive motor and the DC power is used for the electronics and the stepper motor.

4.2.1 AC Power

The AC power to the drive is via the connector P4/J4 located to the rear of the drive and below the AC motor capacitor. The P4/J4 pin designations are outlined below for standard as well as optional AC power.

P4 PIN	60 Hz		50 Hz	
	115 V (Standard)	208/230 V	110 V	220 V
1	85-127 VAC	170-253 VAC	85-127 VAC	170-253 VAC
2	Frame Gnd	Frame Gnd	Frame Gnd	Frame Gnd
3	85-127 V Rtn	170-253 V Rtn	85-127 Rtn	170-253 Rtn
MAX CURRENT	0.35 Amps	0.23 Amps	0.35 Amps	0.23 Amps
FREQ TOLERANCE	±0.5 Hz		±0.5 Hz	

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4.2.2 DC Power

DC power to the drive is via connector P5/J5 located on non-component side of PCB near the P4 connector. The three DC voltages and their specifications along with their P5/J5 pin designators, are outlined below.

P5 PIN	DC VOLTAGE	TOLERANCE	CURRENT	MAX RIPPLE (p to p)
1	+24 VDC	±1.2 VDC	1.7 A Max** 1.3 A Typ	100 mv
2	+24 V Return*			
3	– 5 V Return			
4	–7 to –16 VDC		0.1 A Max 0.07 A Typ	
	Optional – 5.0	±0.25 VDC	0.07 A Max 0.05 A Typ	50 mv
5	+ 5 VDC	±0.25 VDC	1.0 A Max 0.8 A Typ	50 mv
6	+ 5 V Return			

*The +24 VDC power requires a separate ground return line. It, and all other DC grounds must be connected together near the power supply. One line from this common DC connection must go to one common Frame Ground connection.

**If either customer installable option described in sections 7.2 and 7.4 are used, the current requirement for the +24 VDC is a multiple of the maximum +24V current times the number of drives on the line.

5.0 PHYSICAL INTERFACE

The electrical interface between the SA850/851 and the host system is via three connectors. The first connector, J1, provides the signal interface; the second connector, J5, provides the DC power; and the third connector, J4, provides the AC power and frame ground.

This section describes the physical connectors used on the drive and the recommended connectors to be used with them. Refer to Figure 17 for connector locations.

5.1 J1/P1 Connector

Connection to J1 is through a 50 pin PCB edge card connector. The dimensions for this connector are shown in Figure 14. The pins are numbered 1 through 50 with the even numbered pins on the component side of the PCB and the odd numbered pins on the non-component side. Pin 2 is located on the end of the PCB connector closest to the AC motor capacitor and is labeled 2. A key slot is provided between pins 4 and 6 for optional connector keying.

The recommended connectors for P1 are tabulated below.

TYPE OF CABLE	MANUFACTURER	CONNECTOR P/N	CONTACT P/N
Twisted Pair, #26* (crimp or solder)	AMP	1-583717-1	583616-5 (crimp) 583854-3 (solder)
Twisted Pair, #26 (solder term.)	VIKING	3VH25/1JN-5	NA
Flat Cable	3M "Scotchflex"	3415-0001	NA

*The AMP edge connector and crimp type pins are available as an accessory from Shugart, order P/N50604 Signal Connection Kit.
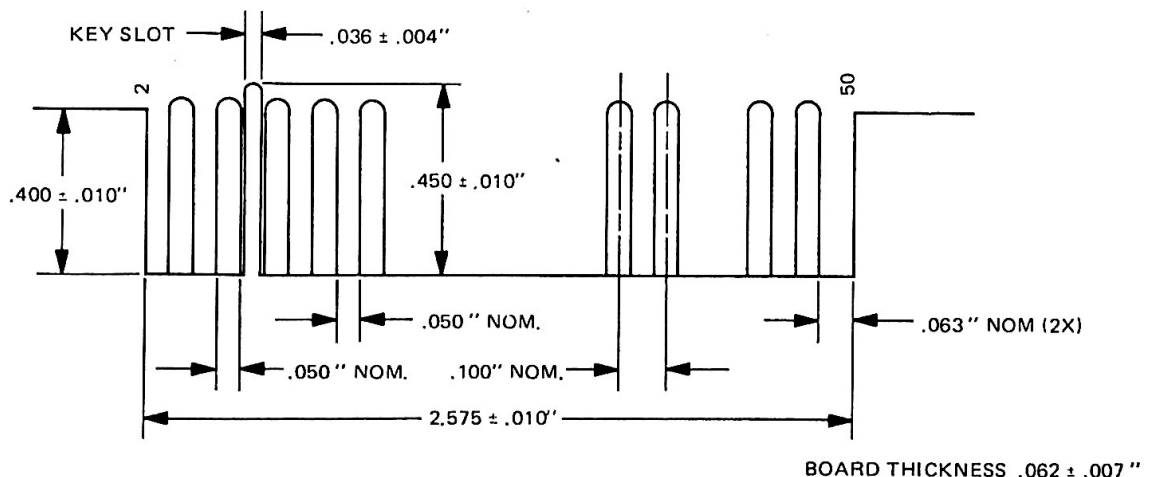

BOARD THICKNESS .062 ± .007 "

FIGURE 14. J1 CONNECTOR DIMENSIONS

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5.2 J5/P5 Connector

The DC power connector, J5, is mounted on the non-component side of the PCB and is located below the AC motor capacitor. J5 is a 6 pin AMP Mate-N-Lok connector P/N 1-380999-0. The recommended mating connector (P5) is AMP P/N 1-480270-0 utilizing AMP pins P/N 60619-1. J5 pins are labeled on the component side of the PCB with pin 5 located nearest J1/P1. Figure 15 illustrates J5 connector as seen on the drive PCB from non-component side.
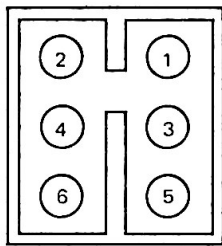
5.3 J4/P4 Connector

The AC power connector, J4, is mounted on the AC motor capacitor bracket and is located just below the capacitor. J4 connector is a 3 pin connector AMP P/N 1-480701-0 with pins P/N 350547-1, 2 EA. and 350654-1, 1 EA. The recommended mating connector (P4) is AMP P/N 1-480700-8 utilizing pins 350550-1. Figure 16 illustrates J4 connector as seen from the rear of the drive.
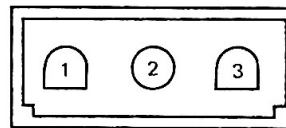
FIGURE 15. J5 CONNECTOR

FIGURE 16. J4 CONNECTOR
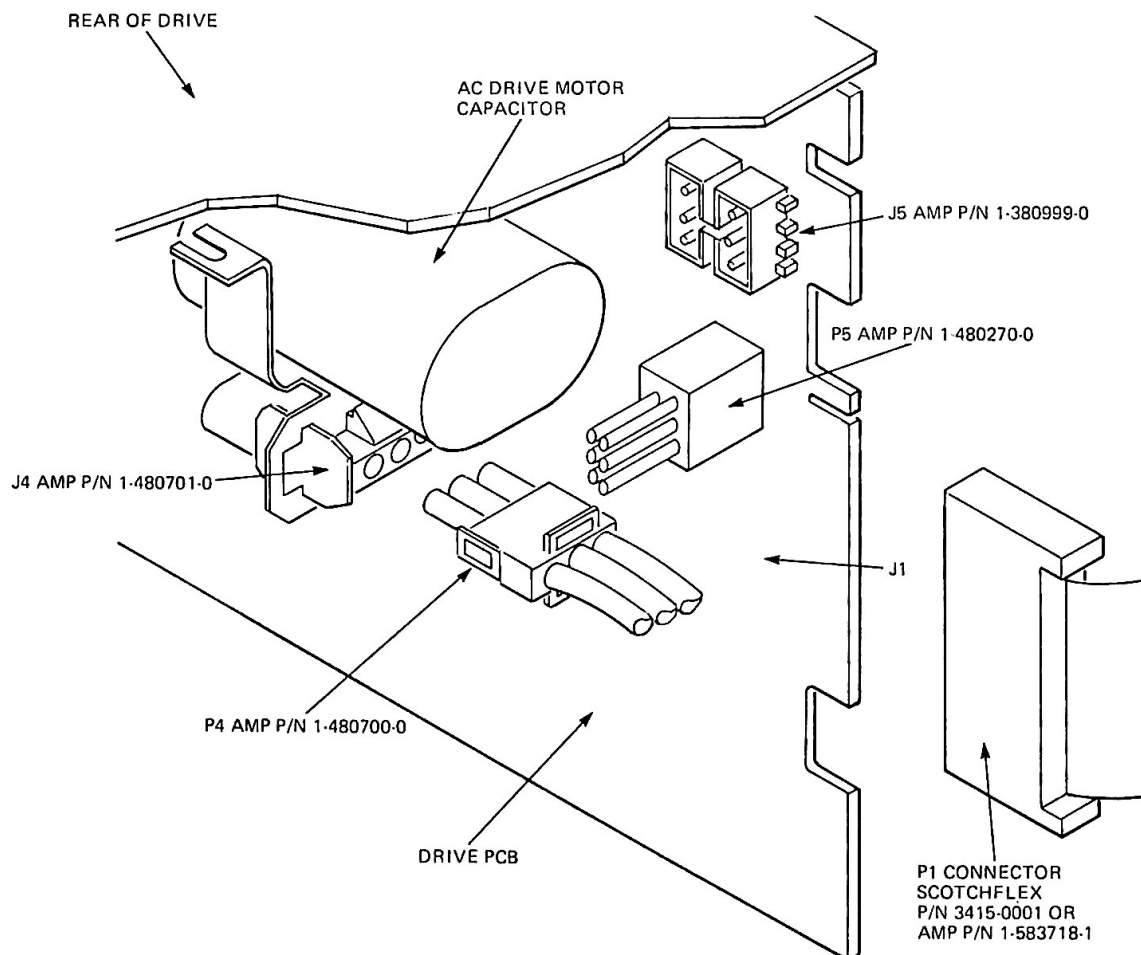
FIGURE 17. INTERFACE CONNECTORS—PHYSICAL LOCATION DIAGRAM

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6.0 DRIVE PHYSICAL SPECIFICATIONS

This section describes the mechanical dimensions and mounting recommendations for the SA850/851.

6.1 Drive Dimensions

Reference Figure 18 for dimensions of the SA850/851.

6.2 Mounting Recommendations

The SA850/851 is capable of being mounted in one of the following positions with no mechanical adjustments:

1. Vertical — Door opening to the left or right.

2. Horizontal — Door opening up or down.

3. Upright — Door opening towards the front or rear.

FIGURE 18. SA850/851 DISKETTE STORAGE DRIVE DIMENSIONS

6.3 Chassis Slide

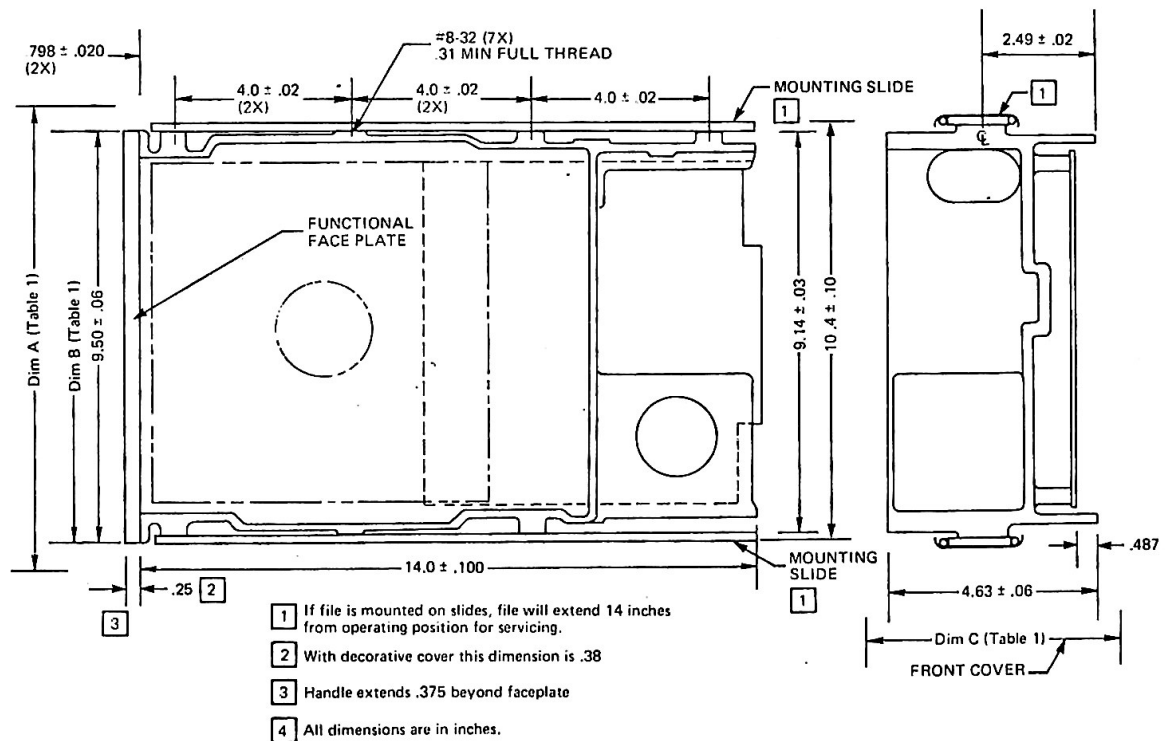Available as an optional accessory is a chassis slide kit P/N 50239. This kit contains two slides, one locking and one non-locking, and seven screws. Dimensions of the slide are shown in Figure 19.
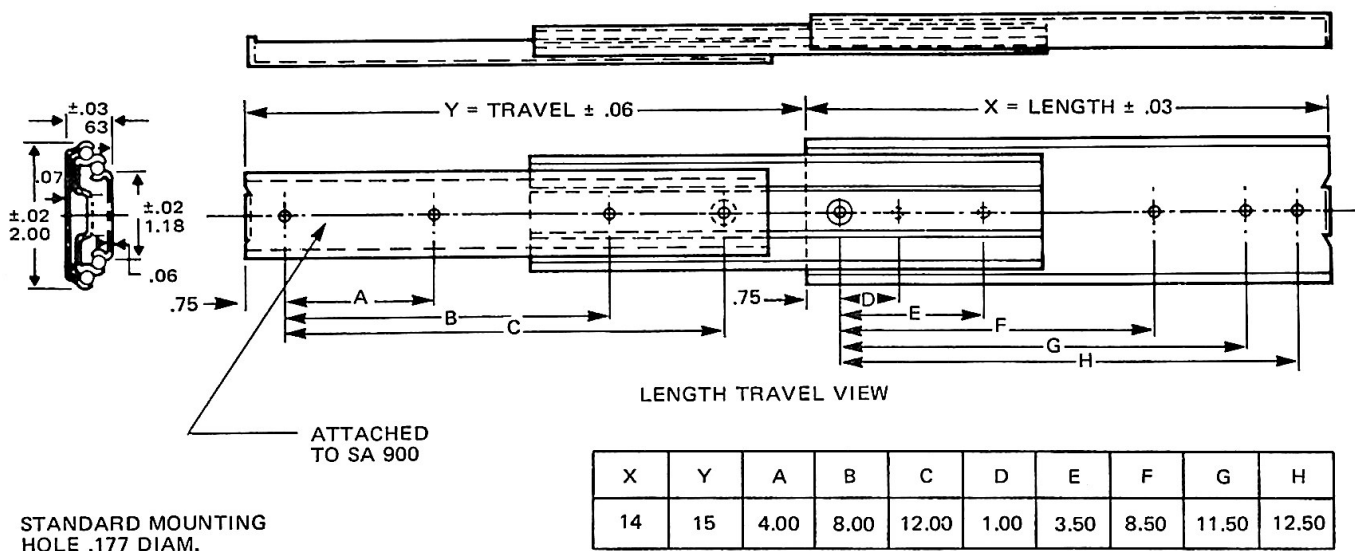
LENGTH TRAVEL VIEW

ATTACHED TO SA 900

STANDARD MOUNTING HOLE .177 DIAM.

X	Y	A	B	C	D	E	F	G	H
14	15	4.00	8.00	12.00	1.00	3.50	8.50	11.50	12.50

FIGURE 19. SLIDE MOUNTING DIMENSIONS

6.4 Decorative Face Plate

The SA800/801 may be ordered with one of the following decorative face plates:

SIZE	COLOR
4 5/8 x 10 1/2	Tan
4 5/8 x 10 1/2	White
5 1/4 x 10	Tan
5 1/4 x 10	White
5 1/4 x 11	Tan
5 1/4 x 11	White
"R" Series-4 5/8 x 8 11/16	Tan

If another color is required to match the system's color scheme, the face plate may be painted. The following information should be utilized to avoid potential problems in the painting process.

1. The front cover is made from GE's LEXAN. Dimensional stability of LEXAN exists from $-60°F$ to $+250°F$. If the type paint used requires baking, the temperature should not exceed $+250°F$, including any hot spots which can contact the cover.

2. LEXAN is a polycarbonate. Any paint to be used should be investigated to insure that it does not contain chemicals that are solvents to polycarbonates.

FIGURE 20. SA850/851R DIMENSIONS

The following callouts are identified:

1. Dimension is from end of base casting.
2. Cosmetic front cover height.
3. Functional front plate height.
4. Cosmetic front cover width.
5. Functional front plate width.
6. Cosmetic front cover thickness.
7. Functional front plate thickness.
8. Cosmetic front cover color comes only in tan.

Dimensions shown: 4.62 ± .03, 2.49 ± .02, 8.55 ± .03, 14.00 ± .06, 8.00 ± .04 (2X), 8-32 X .25 DP (4X), .80 ± .02 (2X), 4.50 ± .02, 4.62 ± .02, 3.50 ± .01, 1.00 ± .01, .54 (REF), .38 ± .01, .25 ± .01, 7.47 ± .06, 8.55 ± .02, 8.68 ± .02, .54 ± .02

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7.0 CUSTOMER INSTALLABLE OPTIONS

The SA850/851 can be modified by the user to function differently than the standard method as outlined in sections 3 and 4. These modifications can be implemented by adding or deleting traces and by use of the Alternate I/O pins. Some traces are capable of being connected by use of a shorting plug, Shugart P/N 15648 or AMP P/N 530153-2. This section will discuss a few examples of modifications and how to install them. The examples are:

1. Drive Select one to eight drives.
2. Select drive without loading head or enabling stepper.
3. Select drive and enable stepper without loading head.
4. Load head without selecting drive or enabling stepper.
5. Radial Ready.
6. Radial Index/Sector.
7. Eight, 16, or 32 Sector option.
8. In Use (Activity L.E.D.) optional input.
9. Write Protect options.
10. Side selection.

Tabulated on page 27 are the trace options with the condition of the trace as it is shipped from the factory. Figure 22 shows the location of these traces on the PCB.
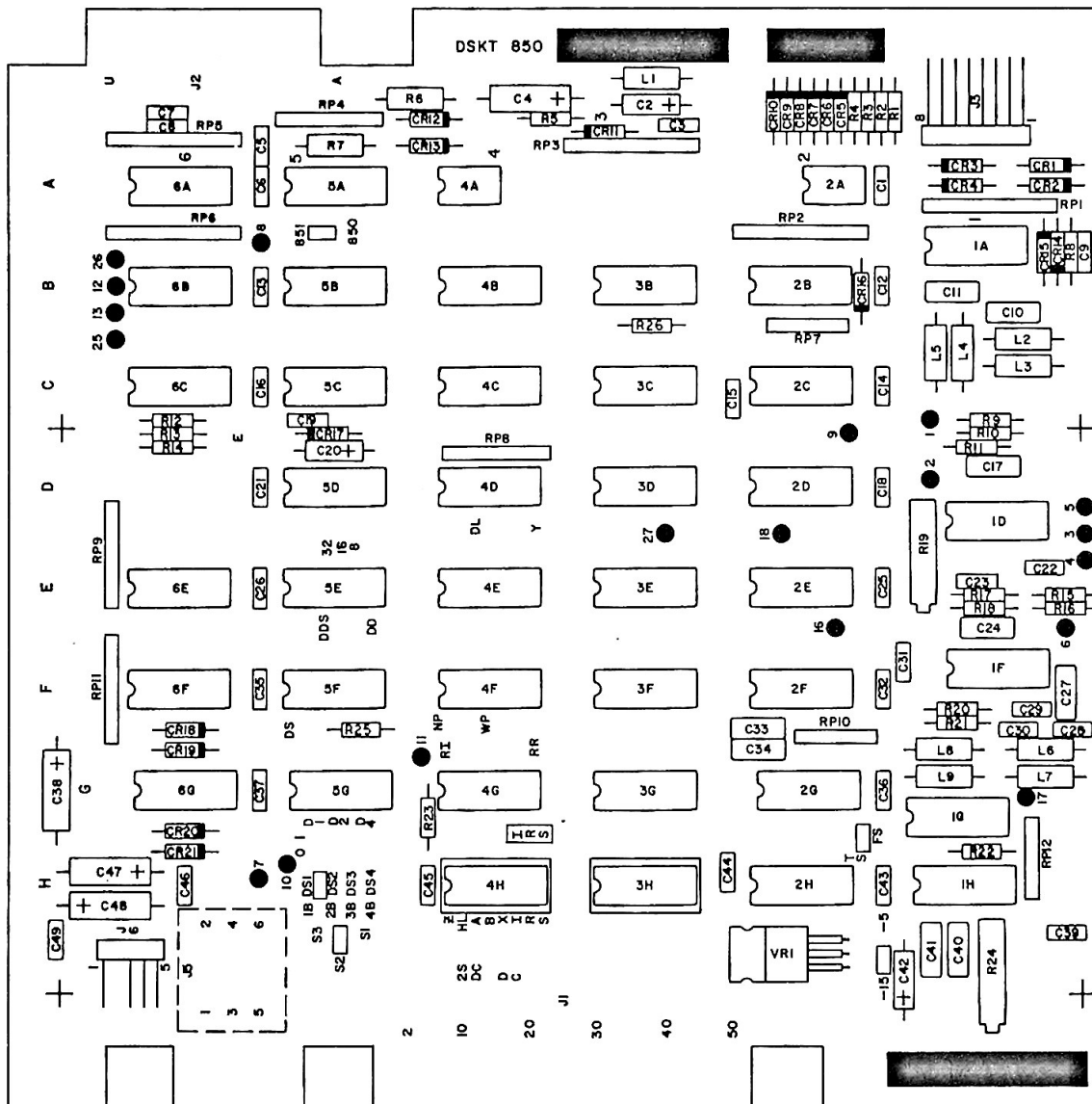
PCB COMPONENT LOCATIONS

CUSTOMER CUT/ADD TRACE OPTIONS

TRACE DESIGNATOR	DESCRIPTION	SHIPPED FROM FACTORY	
		OPEN	SHORT
3H	Terminations for Multiplexed Standard Inputs		Plugged
RP9	Pull Up for Multiplexed Optional Inputs		
DS1	Drive Select 1 Input Pin		X
DS2,3,4	Drive Select 2,3,4 Input Pins	X	
1B,2B,3B,4B	Side Select Option Using Drive Select	X	
RR	Radial Ready		X
RI	Radial Index and Sector		X
R (SHUNT 4H)*	Option Shunt for Ready Output		X
2S	Two-Sided Status Output	X	
850/851	Sector Option Enable	850	851
I (SHUNT 4H)*	Index Output		X
S (SHUNT 4H)*	Sector Output		X
8,16,32	8, 16, 32 Sectors	8,16	32
DC	Disk Change Option	X	
HL (SHUNT 4H)*	Stepper Power From Head Load		X
DS	Stepper Power From Drive Select	X	
WP	Inhibit Write When Write Protected		X
NP	Allow Write When Write Protected	X	
D	Alternate Input-In Use	X	
D1,D2,D4,DDS	Decode Drive Select Option	X	
DD	Standard Drive Select Enable		X
DL	Door Lock Latch Option		X
A,B,X.(SHUNT 4H)*	Radial Head Load		X
C	Alternate Input-Head Load	X	
Z (SHUNT 4H)*	In Use From Drive Select		X
Y	In Use From Head Load	X	
S1	Side Select Option Using Direction Select	X	
S2	Standard Side Select Input		X
S3	Side Select Option Using Drive Select	X	
TS,FS	Data Separation Option Select TS = True Separation. Data is on the Sep Data Line. Clock on the Sep Clock Line. FS = False Separation (as in SA800/900 Series). The Data Separator goes out of phase in the Address Mark Fields.	FS	TS

*A 16 pin programmable shunt (location 4H) is provided for the eight most commonly used cut trace options. These traces are usually shorted as shipped from the factory. The traces can be opened as follows:

1. Cut the trace using a Strap Cutter AMP P/N 435705.

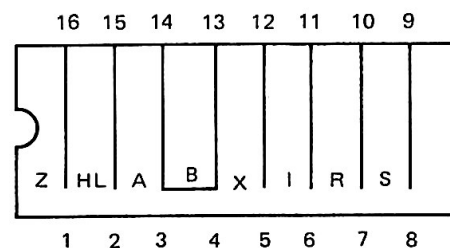2. Remove the shunt and bend out the desired pin.

FIGURE 21. 16 PIN PROGRAMMABLE SHUNT

7.1 Drive Select — One To Eight Drives

This customer installed option allows up to eight drives to be multiplexed together. This method of drive selection uses a binary address to select a drive.

To install this feature on a standard drive, the following traces should be added or deleted:

1. Add a 74L85, 4 bit comparator, into position 5G on PCB.

2. Connect trace 'DDS'.

3. Remove trace 'DD'.

4. Insure traces 'DS1' — 'DS4' are unplugged.

5. Jumper traces 'D1', 'D2', and 'D4' according to table below for the address of each drive.

The four Drive Select lines are to be used for addressing the drives. Pin 26 is used as Drive Select enable and pins 28 (binary 1), 30 (binary 2), and 32 (binary 4) are the address lines. The table below shows the logical state each line must be at to select each of the drives.

ADDRESS	TRACE		
	D1	D2	D4
0	0	0	0
1	1	0	0
2	0	1	0
3	1	1	0
4	0	0	1
5	1	0	1
6	0	1	1
7	1	1	1

DRIVE	INTERFACE PIN			
	26	28	30	32
0	0	1	1	1
1	0	0	1	1
2	0	1	0	1
3	0	0	0	1
4	0	1	1	0
5	0	0	1	0
6	0	1	0	0
7	0	0	0	0

Figure 22 illustrates the circuitry.

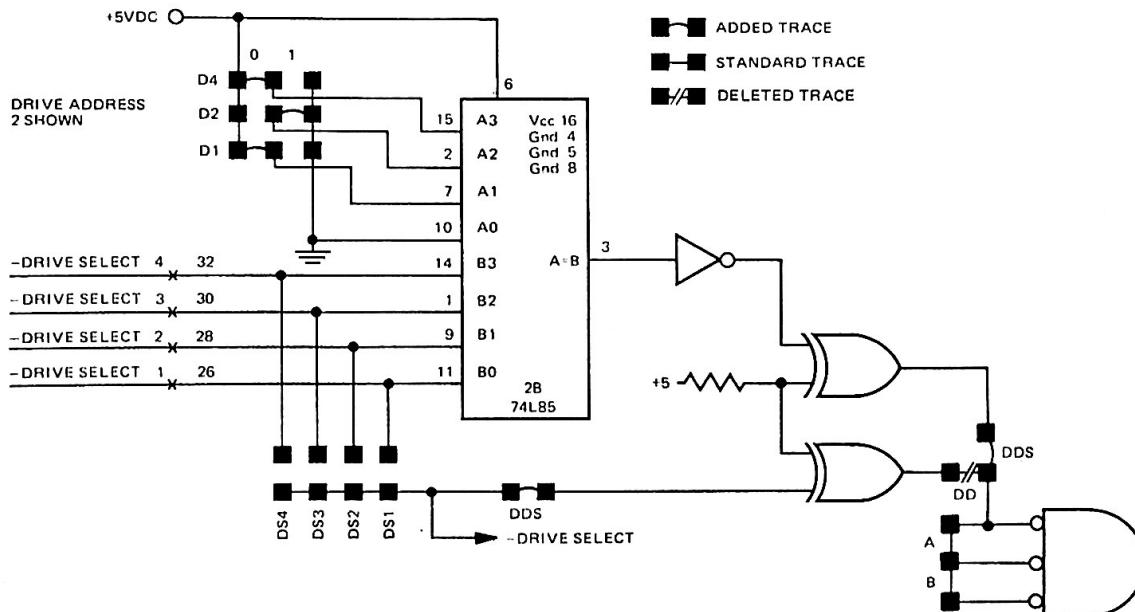The four drive select lines must be terminated externally.

FIGURE 22. DRIVE SELECT CIRCUITRY

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7.2 Select Drive Without Loading Heads Or Enabling Stepper Motor

This option would be advantageous to the user who requires a drive to be selected at all times. Normally, when a drive is selected, its heads are loaded and the stepper motor is energized. The advantage of this option would be that the output control signals could be monitored while the heads were unloaded thereby extending the head and media life. When the system requires the drive to perform a Read, Write, or Seek, the controller would activate the Head Load line (pin 18) which in turn would load the heads and energize the stepper motor. After the Head Load line is activated, a 35 ms delay must be introduced before Write Gate and Write Data may be applied or before Read Data is valid.

To install this option on a standard drive, the following traces should be added or deleted:

1. Cut trace 'X'.

2. Jumper trace 'C'.

Figure 23 illustrates the circuitry.

7.3 Select Drive and Enable Stepper Without Loading Heads

This option is useful to the user who wishes to select a drive and perform a seek operation without the heads being loaded or with door open. An example use of this option is that at power on time, an automatic recalibrate (reverse seek to track zero) operation could be performed with the drive access door open. Normally for a seek to be performed, the door must be closed and the heads loaded. Other advantages are those listed in section 7.2 in addition to being able to monitor Track Zero. When a Read or Write operation is to be performed, the heads must be loaded (pin 18). After the Head Load line is activated, a 35 ms delay must be introduced before Write Gate and Write Data may be applied or before Read Data is valid.

To install this option on a standard drive, the following traces should be added or deleted:

1. Cut trace 'B'.

2. Jumper trace 'DS'.

3. Cut trace HL.

4. Jumper trace 'C'.

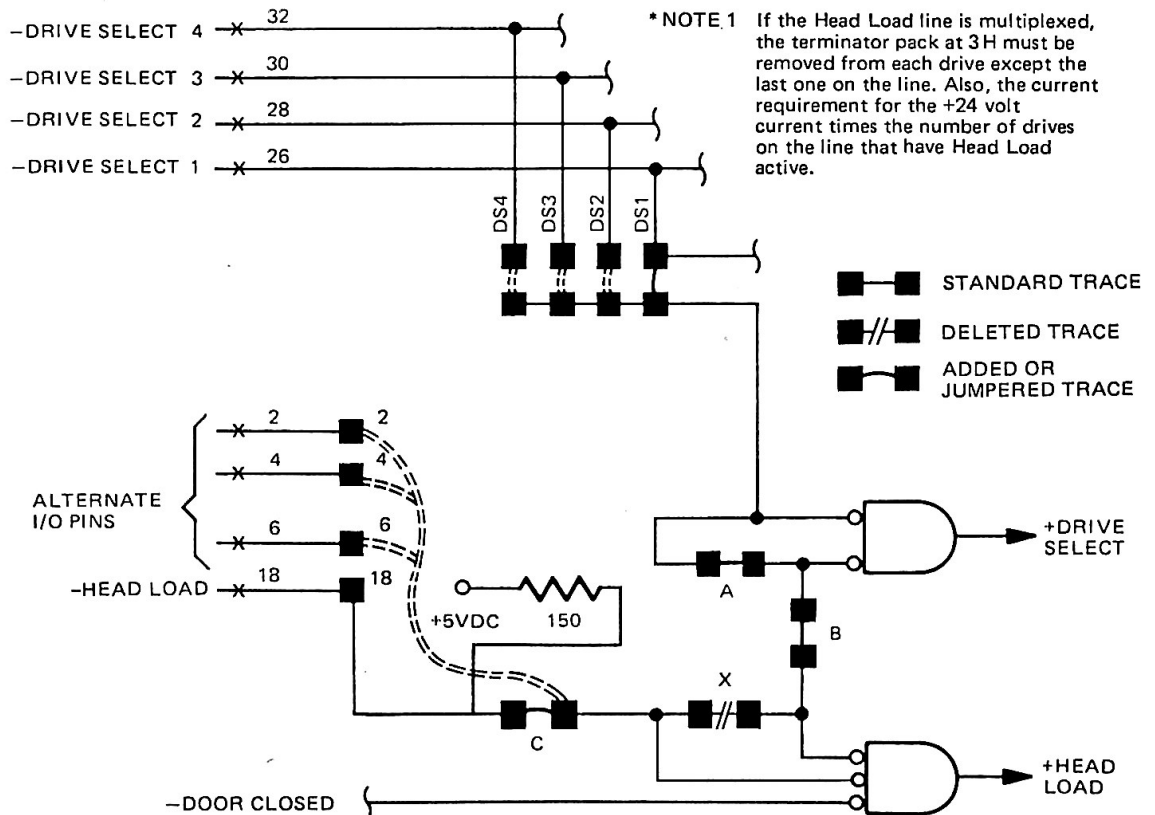Figures 23 and 24 illustrate the circuitry.

*NOTE 1 If the Head Load line is multiplexed, the terminator pack at 3 H must be removed from each drive except the last one on the line. Also, the current requirement for the +24 volt current times the number of drives on the line that have Head Load active.

FIGURE 23. SELECT DRIVE WITHOUT LOADING HEAD CIRCUIT

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7.4 Load Heads Without Selecting Drive Or Enabling Stepper

This option is useful in disk to disk copy operations. It allows the user to keep the heads loaded on all drives thereby eliminating the 35 ms head load time. The heads are kept loaded on each drive via an Alternate I/O pin. Each drive may have its own Head Load line (Radial or Simplexed) or they may share the same line (Multiplexed). When the drive is selected, an 18 ms delay must be introduced before a Read or Write operation can be performed. This is to allow the R/W heads to settle after the stepper motor is energized. With this option installed, a drive can only be selected with both -Drive Select and -Head Load active.

To install this option on standard drive, the following traces should be added or deleted:

1. Cut trace 'A'.

2. Jumper trace 'DS'.

3. Cut trace HL.

*4. Jumper trace 'C'.

*If the -Head Load line is multiplexed, termination pack 3H jumper must be removed from each drive except the last one on the line.

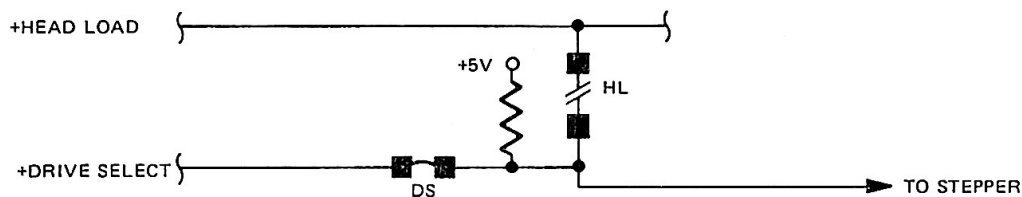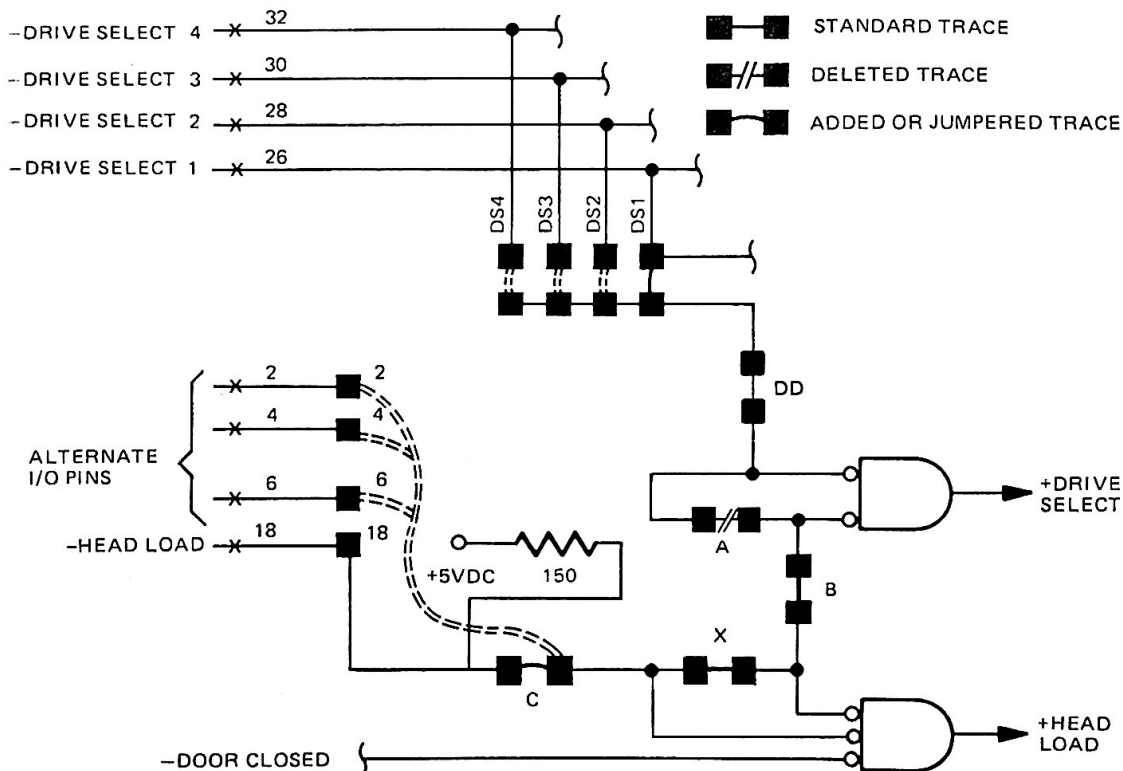Figure 24 and 25 illustrates the circuitry.

FIGURE 24. STEPPER MOTOR ENABLE CIRCUIT

*If the –Head Load line is multiplexed, termination pack 3H must be removed from each drive except the last one on the line.

FIGURE 25. LOAD HEAD WITHOUT SELECTING DRIVE OR ENABLING STEPPER CIRCUIT

7.5 Radial Ready

This option enables the user to monitor the Ready line of each drive on the interface. This can be useful in detecting when an operator has removed or installed a Diskette in any drive. Normally, the Ready line from a drive is only available to the interface when it is selected.

To install this option on a standard drive, the following traces should be added or deleted:

1. Cut trace 'RR'.

*2. Cut trace 'R'.

*3. Add a wire from pad 'R' to one of the Alternate I/O pins.

*One of the drives on the interface may use pin 22 as its Ready line, therefore, steps 2 and 3 may be eliminated on this drive. All the other drives on the interface must have their own Ready line, therefore steps 2 and 3 must be incorporated.

Figure 26 illustrates the circuitry.

7.6 Radial Index/Sector

This option enables the user to monitor the Index and Sector lines at all times so that the drive may be selected just prior to the sector that is to be processed. This option can be used to reduce average latency.

To install this option on a standard drive the following traces should be added or deleted:

1. Cut trace 'RI'.

*2. Cut trace 'I'.

*3. Cut trace 'S'.

*4. Add a wire from trace 'I' to one of the Alternate I/O pins.

*5. Add a wire from trace 'S' to one of the Alternate I/O pins.

*One of the drives on the interface may use pin 20 (-Index) and pin 24 (-Sector) as its Index and Sector lines, therefore, steps 2 - 5 may be eliminated for this drive. All other drives on the interface must have their own Index and Sector lines, therefore, steps 2 - 5 must be incorporated.
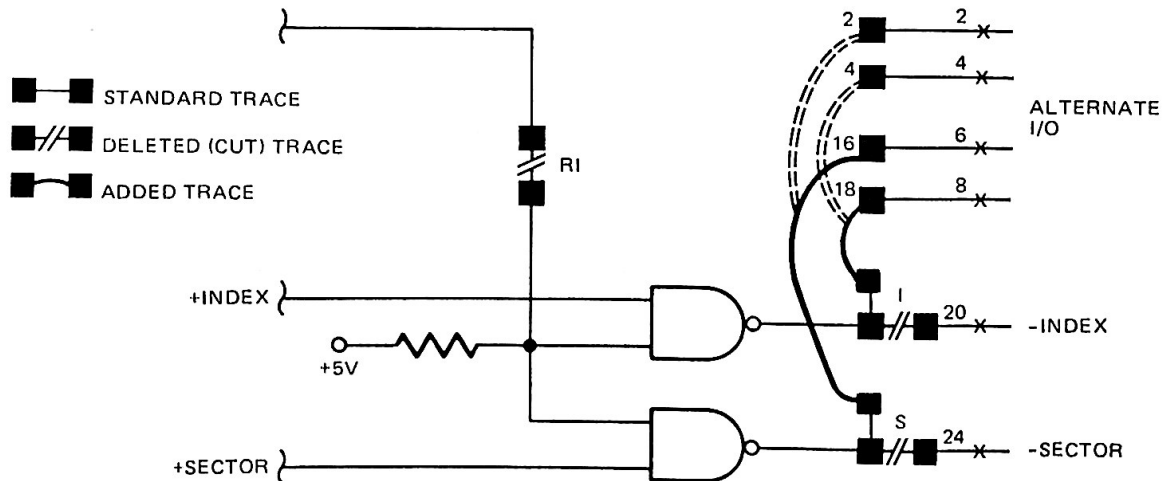
Figure 27 illustrates the circuitry.

FIGURE 26. RADIAL READY CIRCUIT


FIGURE 27. RADIAL INDEX/SECTOR CIRCUIT

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7.7 Eight, 16, Or 32 Sectors

The SA851, as shipped from the factory, is set up to provide 32 Sector pulses per revolution of the Diskette onto the interface. This option is provided for the user who wishes to have eight or 16 Sectors per revolution. The logic divides the Sector pulses by two or four. Reference Figure 28 for the timing relationships.

To install this option on a standard drive (SA851) the following traces should be added or deleted:

1. Cut trace '32'.

2. Connect trace '16' for 16 Sectors or connect trace '8' for eight Sectors.

Figure 29 illustrates the circuitry.
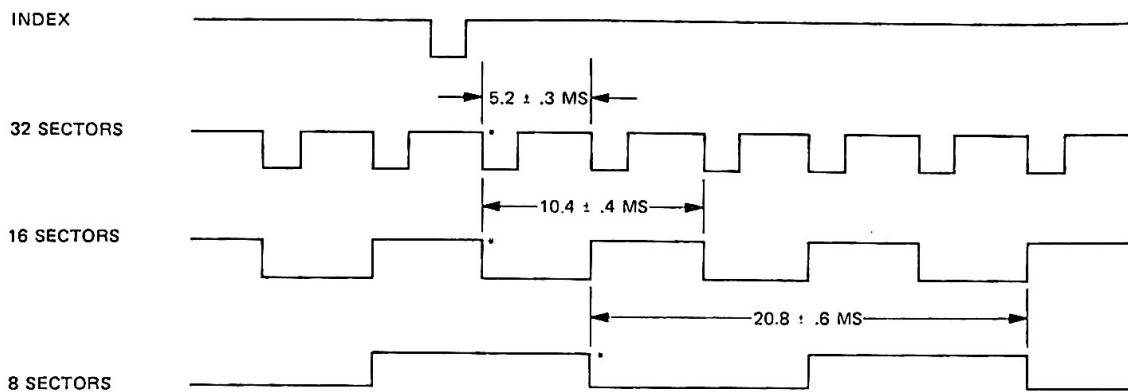
*INDICATES BEGINNING SECTOR 1 IN RELATIONSHIP TO INDEX
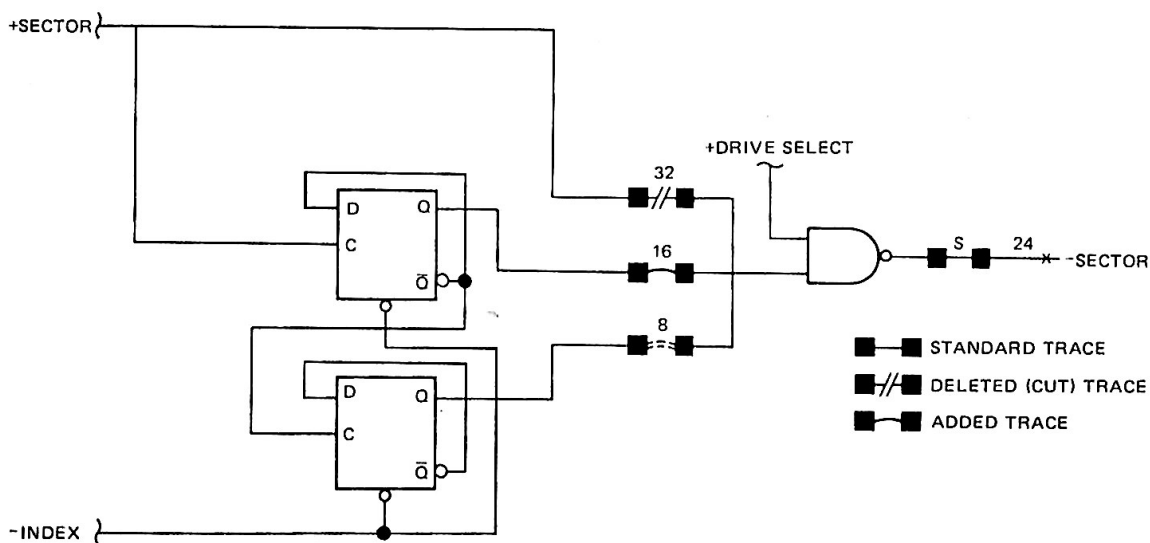
FIGURE 28. SECTOR TIMING RELATIONSHIPS

FIGURE 29. SECTOR DIVIDE CIRCUIT

7.8 In Use Alternate Input (Activity LED)

This alternate input, when activated to a logical zero level, will turn on the Activity LED mounted in the push bar on the front panel and locks the door of the drive.

To install this option on standard drive, jumper trace 'D' and activate the interface line pin 16.

This signal is an "OR" function with Drive Select or Head Load. Figure 30 illustrates the circuitry. For other uses, reference section 7.13.
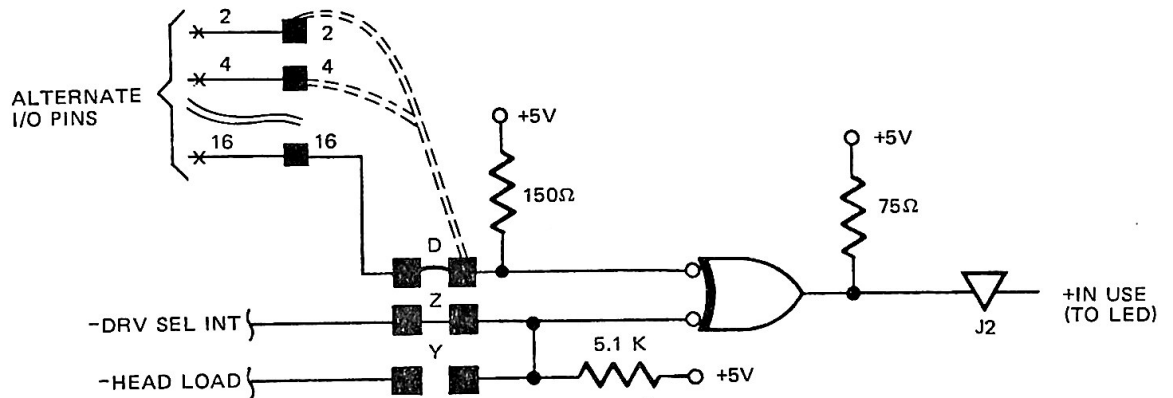

FIGURE 30. IN USE/ACTIVITY LED CIRCUIT

7.9 Write Protect Optional Use

As shipped from the factory, the optional Write Protect feature will internally inhibit writing when a Write Protected Diskette is installed. With this option installed, a Write Protected Diskette will not inhibit writing, but it will be reported to the interface. This option may be useful in identifying special use Diskettes.

To install this option on a drive with the Write Protect feature, the following traces should be added or deleted:

1. Cut trace 'WP'.

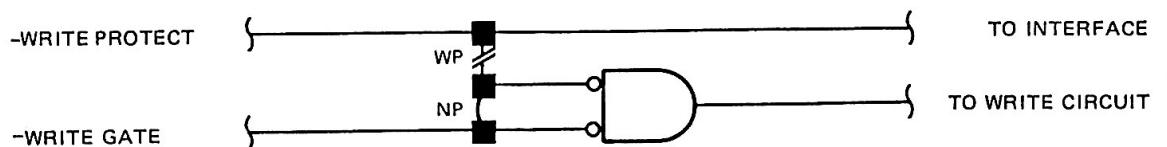2. Connect trace 'NP'.

Figure 31 illustrates the circuitry.

FIGURE 31. WRITE PROTECT CIRCUIT

7.10 Disk Change (Alternate Output)

This customer installable option is enabled by jumpering trace 'DC'. It will provide a true signal (logical zero) onto the interface (pin 12) when Drive Select is activated if while deselected the drive has gone from a Ready to a Not Ready (Door Open) condition. This line is reset on the true to false transition of Drive Select if the drive has gone Ready. Timing of this line is illustrated in Figure 32. The circuitry is illustrated in Figure 33.
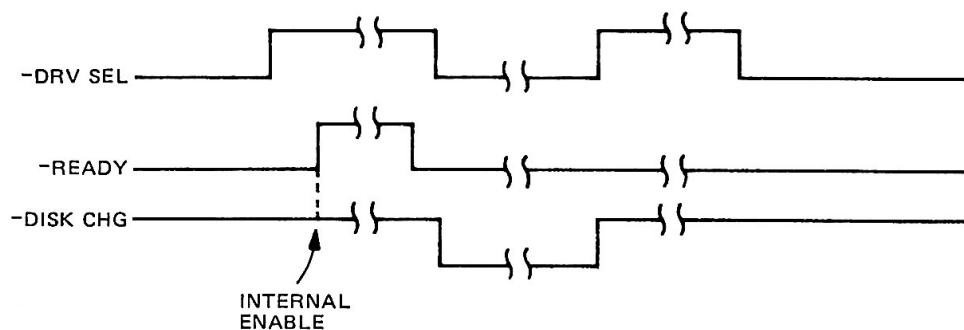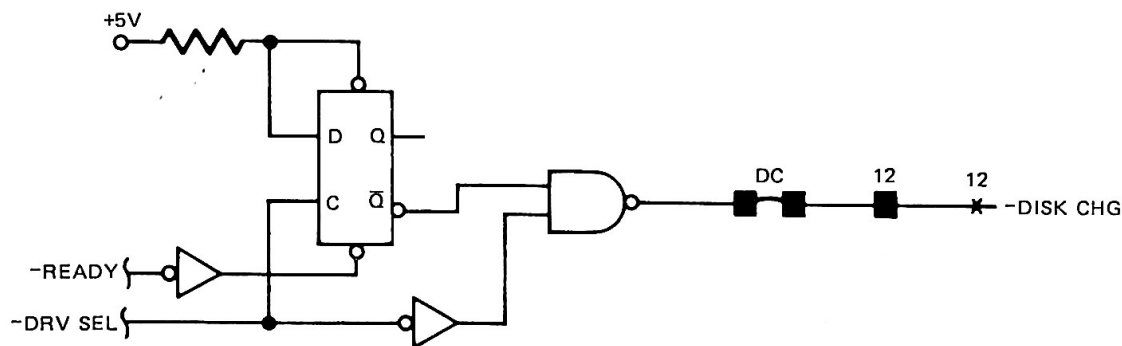

FIGURE 32. DISK CHANGE TIMING

FIGURE 33. DISK CHANGE CIRCUIT

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7.11 Side Selection, Using Direction Select

The Side Select function can be controlled via the Direction Select line, if desired. With this option, the Direction Select line controls the direction of head motion during stepping operations and controls side (head) selection during read/write operations. To implement this option, simply move jumper S2 to location S1.

Figure 34 illustrates the circuitry.

7.12 Side Selection Using Drive Select.

In systems containing no more than two SA850/851 drives per controller, each R/W head can be assigned a separate drive address. In such cases,

the four Drive Select lines can be used to select the four R/W heads. To implement this option, move jumper S2 to S3 and add a jumper to nB (n = 1, 2, 3 or 4). For example, the first drive may have jumpers installed at DS1 and 2B while the second drive has jumpers at DS3 and 4B. With this jumper configuration installed, the four Drive Select lines have the following side selection functions.

1. Drive Select 1 selects side 0 of first drive.
2. Drive Select 2 selects side 1 of first drive.
3. Drive Select 3 selects side 0 of second drive.
4. Drive Select 4 selects side 1 of second drive.
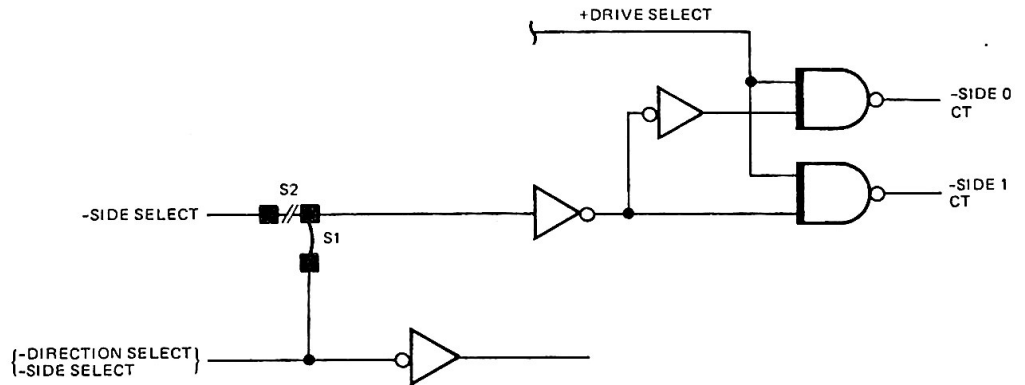
Figure 35 illustrates the circuitry.

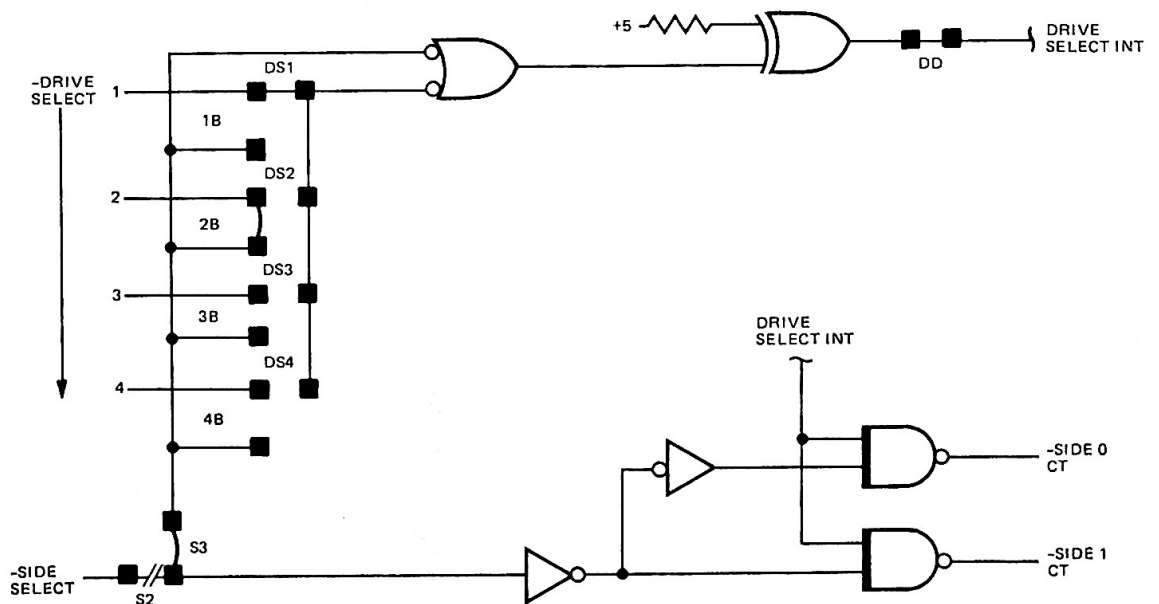FIGURE 34. SIDE SELECTION, USING DIRECTION SELECT

FIGURE 35. SIDE SELECTION, USING DRIVE SELECT

7.13 Door Lock Latch

The door lock circuit can be latched on under Drive Select control so that the door can remain locked without maintaining the active state of In Use. To implement this option, install jumpers at D and DL. Then, if the appropriate Drive Select line is activated while In Use is active, a latch will be set, which holds the door lock circuit active. To unlock the door, Drive Select is again activated while In Use is inactive.

Figure 36 illustrates the circuitry for this option.

7.14 Two-Sided

This signal indicates whether a Two-Sided (True Output) or a Single-Sided (False Output) Diskette is installed. To implement this option, install a jumper at 2S.
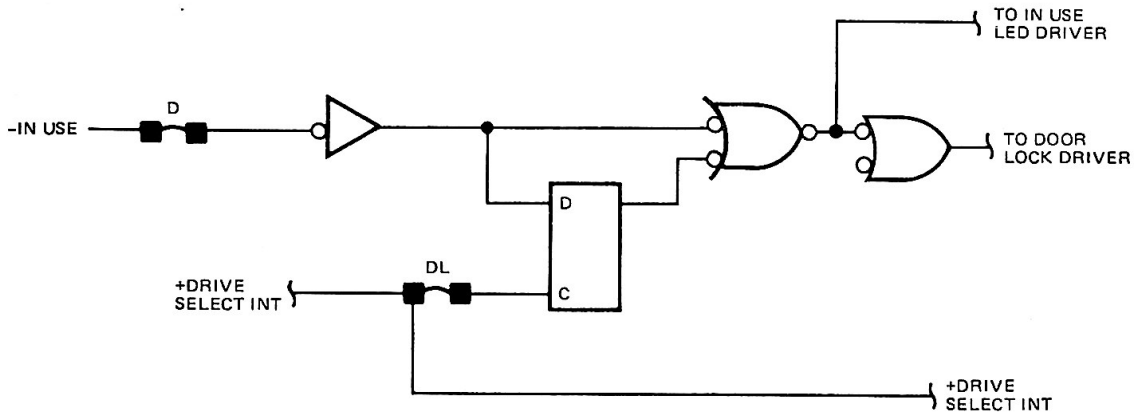

FIGURE 36. DOOR LOCK LATCH CONTROL

8.0 OPERATION PROCEDURES

The SA850/851 was designed for ease of operator use to facilitate a wide range of operator oriented applications. The following section is a guide for the handling and error recovery procedures on the diskette and diskette drive.

8.1 Diskette Loading and Handling

The diskette is a flexible disk enclosed in a plastic jacket. The interior of the jacket is lined with a wiping material to clean the disk of foreign material. Figure 37 shows the proper method of loading a diskette in the SA850/851 Diskette Storage Drive. To load the diskette, depress latch, insert the diskette with the label facing out. (See Figure 37.) Move the latch handle to the left to lock diskette on drive spindle. The diskette can be loaded or unloaded with all power on and drive spindle rotating.
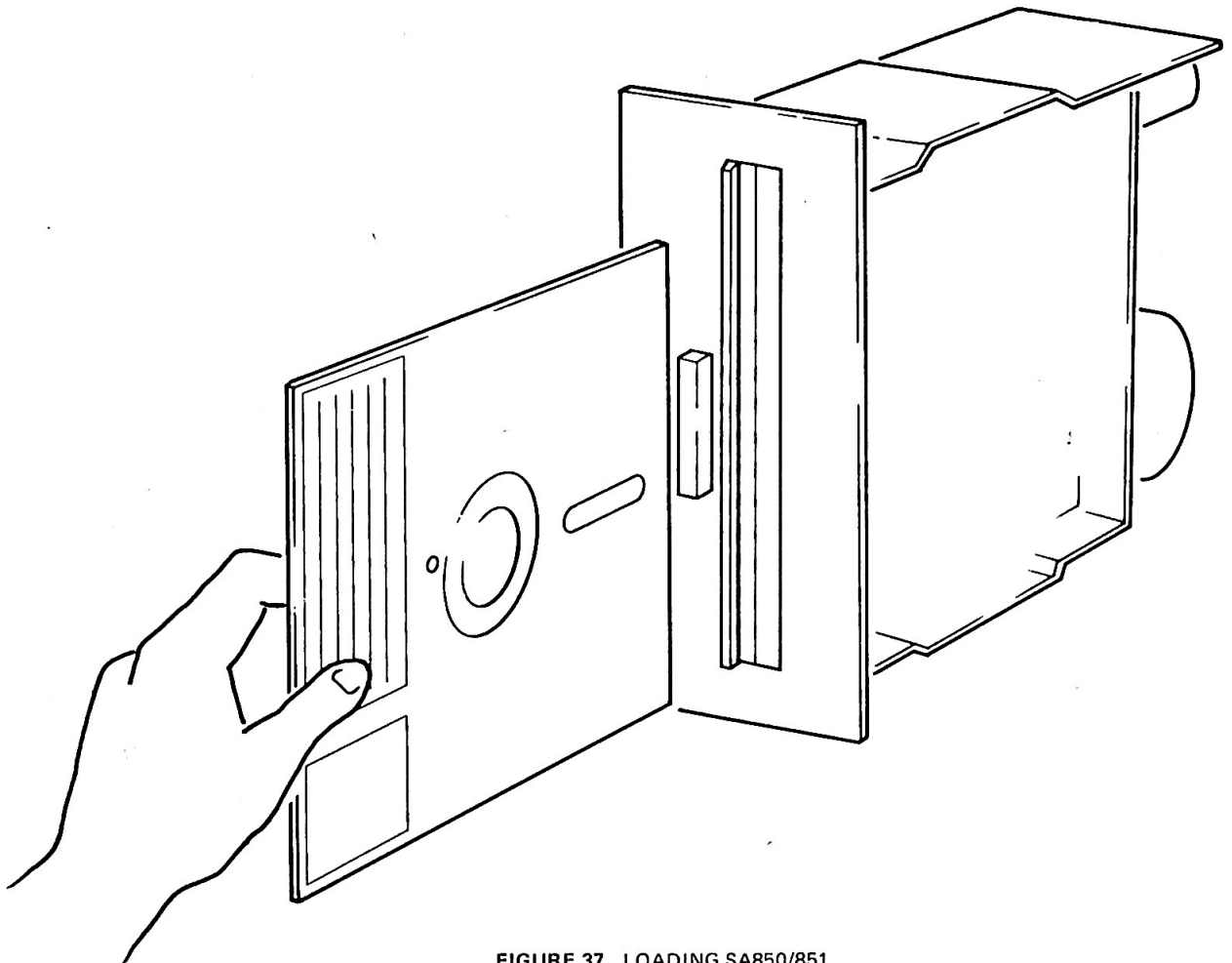

FIGURE 37. LOADING SA850/851

When removed from the drive, the diskette is stored in an envelope. To protect the diskette, the same care and handling procedures specified for computer magnetic tape apply. These precautionary procedures are as follows:

1. Return the diskette to its storage envelope whenever it is removed from file.

2. Keep cartridges away from magnetic fields and from ferromagnetic materials which might become magnetized. Strong magnetic fields can distort recorded data on he disk.

3. Replace storage envelopes when they become worn, cracked or distorted. Envelopes are designed to protect the disk.

4. Do not write on the plastic jacket with a lead pencil or ball-point pen. Use a felt tip pen.

5. Head and contamination from a carelessly dropped ash can damage the disk.

6. Do not expose diskette to heat or sunlight.

7. Do not touch or attempt to clean the disk surface. Abrasions may cause loss of stored data.

8.2 SA151 Write Protect

The SA150/151 has the capability of being write protected. The write protect feature is selected by the hole in the SA150/151. When the hole is open it is protected; when covered, writing is allowed. The hole is closed by placing a tab over the front of the hole, and the tab folded over covering the rear of the hole. The Diskette can then be write protected by removing the tab. See Figure 38.

8.3 Write Protect, IBM Diskettes

IBM Diskettes are not manufactured with a write protect hole punched out as are the Shugart Diskettes. To Write-Protect one of these diskettes, a notch must be punched out as specified in Figure 39. The operation of the write protect is that which is outlined in paragraph 8.2.
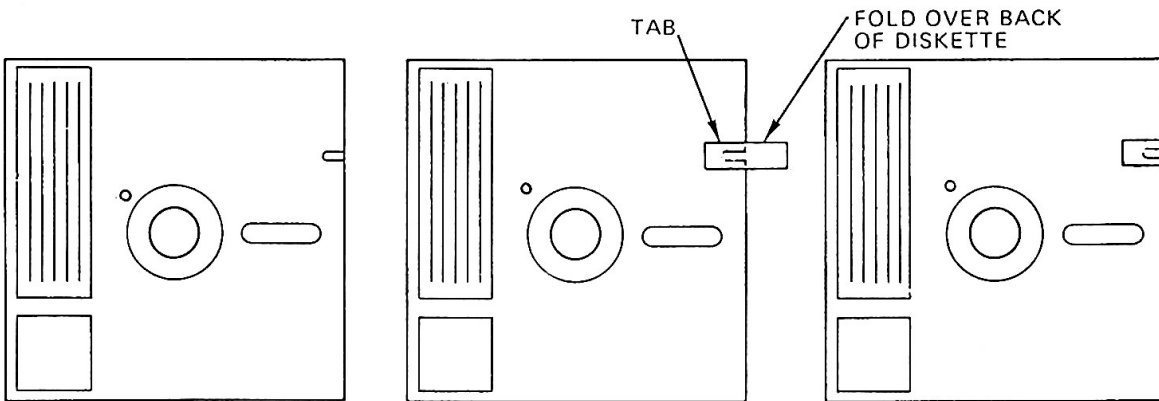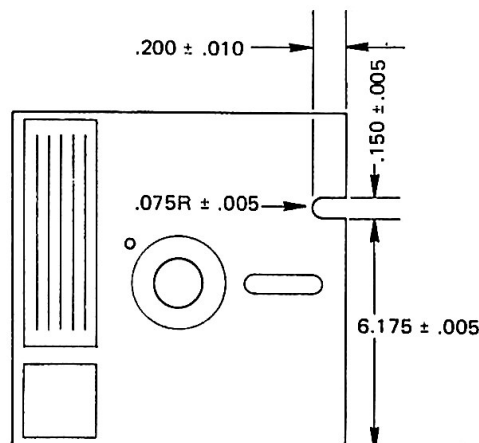
FIGURE 38. DISKETTE WRITE PROTECTED

FIGURE 39. WRITE INHIBIT NOTCH SPECIFICATIONS

9.0 ERROR DETECTION AND CORRECTION

9.1 Write Error

If an error occurs during a write operation, it will be detected on the next revolution by doing a read operation, commonly called a "write check." To correct the error, another write and write check operation must be done. If the write operation is not successful after ten (10) attempts have been made, a read operation should be attempted on another track to determine if the media or the drive is failing. If the error still persists, the disk should be considered defective and discarded.

9.2 Read Error

Most errors that occur will be "soft" errors; that is, by performing an error recovery procedure the data will be recovered.
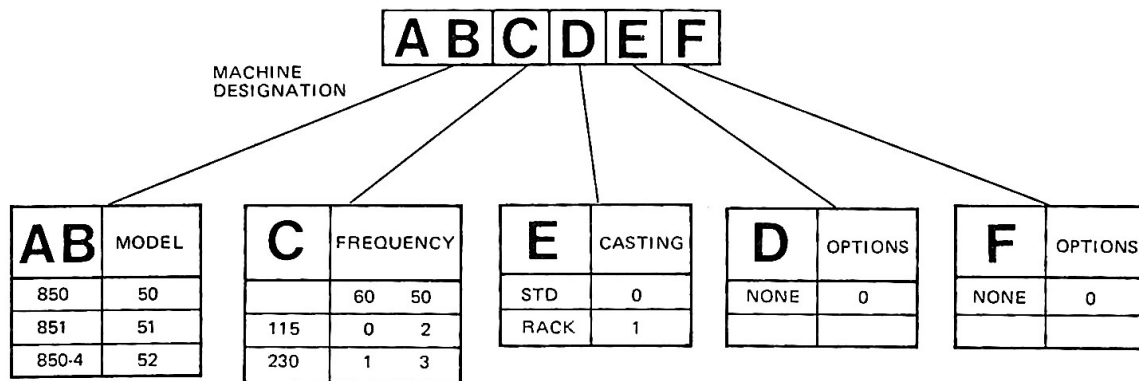
Soft errors are usually caused by:

1. Airborne contaminants that pass between the read/write head and the disk. These contaminants will generally be removed by the cartridge self-cleaning wiper.

2. Random electrical noise which usually lasts for a few μ sec.

3. Small defects in the written data and/or track not detected during the write operation which may cause a soft error during a read.

The following procedures are recommended to recover from the above mentioned soft errors:

1. Reread the track ten (10) times or until such time as the data is recovered.

2. If data is not recovered after using step 1, access the head to the adjacent track in the same direction previously moved, then return to the desired track.

3. Repeat step 1.

4. If data is not recovered, the error is not recoverable.

A B C D E F

MACHINE
DESIGNATION

AB	MODEL
850	50
851	51
850-4	52

C	FREQUENCY	
	60	50
115	0	2
230	1	3

E	CASTING
STD	0
RACK	1

D	OPTIONS
NONE	0

F	OPTIONS
NONE	0

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